

**EXAMINING THE DRIVERS OF ADOPTION OF CLIMATE-SMART PRACTICES IN
SMALLHOLDER FARMING SYSTEMS OF ZVIMBA DISTRICT IN ZIMBABWE**

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DECLARATION

I, Alfred Hamadziripi, declare that this thesis for Doctor of Philosophy in Rural Development (PHDRDV) degree submitted to the Institute for Rural Development, Faculty of Science, Engineering and Agriculture at the University of Venda has not been submitted previously for any degree at this or another university. It is original in design and in execution, and all reference material contained therein has been duly acknowledged.

Signature: _____ **Date:** 16 July 2025

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ABSTRACT

Population growth, increasing urbanisation, competition for and changes in land use, changing diets, and disparities in food supply and demand compounded by the effects of climate change exert pressure on food and agriculture systems. In sub-Saharan Africa, climate change has far-reaching adverse impacts on the livelihoods of smallholder farmers, elevating the urgency to increase agricultural productivity and incomes, and resilience of food and agricultural systems. Discourse is dominated by how climate change risks drive smallholder farmer risk perception and adaptation decision-making. Household risks are less documented for their influence on risk perception. Climate-smart agriculture (CSA) practices have demonstrated positive social, economic and environmental impact, despite sustainability remaining low, raising questions on the adequacy of knowledge on the breadth of the risk context of farmers. This exploratory mixed method study involving smallholder farmers who adopted CSA practices in Zvimba District of Zimbabwe focused on understanding how household risks influenced adaptation decision-making. The data collected using five FGDs and one survey with 55 households was analysed using latent content analysis, Venn diagrams and matrices of consensus combined with frequency analysis, descriptive tabulations, and Fisher's exact test. The study reveals household risks experienced by farmers that include food insecurity, high cost of living, poor housing condition, water, sanitation and hygiene services, illness, lack of access to quality agriculture inputs, crop and livestock pests and diseases, livestock deaths, lack of skills and unemployment and lack of access to land. These co-existed with climate change risks and both influenced perception and decisions to adopt CSA practices and participation in programmes. While some perceived household risks to have been triggered by climate change risks, most viewed them as risks that pre-existed and were independent of climate change risks. The risk consequences of household risks that most farmers were anxious to avoid include failed parenting, loss of self-esteem, social labelling and deviation from values and norms. Though external factors are relevant, being intentional and pragmatic about the multidimensional nature of the risk context of households can guide policies and programmes to include elements that address barriers to scale up and sustainability of adaptation behaviours. The engagement of smallholder farmers and incorporating risks important to them must be fundamental in designing CSA programmes.

Key words: Smallholder farmers, Climate-smart agriculture, climate change risks, household risks, adaptation measures.

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Above all The Greatness of God!

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ABBREVIATIONS

ADER	Average Dietary Energy Requirement for a healthy life
AGRITEX	Agricultural, Technical and Extension Services
AMCEN	African Ministerial Conference on the Environment
AU	African Union
CCSAP	Climate Change Strategy and Action Plan
CSA	Climate-smart agriculture
CSS	Climate-smart agriculture Solution
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GHG	Greenhouse Gases
ICTs	Information and communication technology
IPCC	Intergovernmental Panel on Climate Change
MPPACC	Private Proactive Adaptation to Climate Change
NAP	National Adaptation Plan
NAPAs	National Adaptation Programmes of Action
NAPAs	National Adaptation Programmes
NAPs	National Adaptation Plans
NEPAD	New Partnership for Africa's Development
SADC	Southern African Development Community
SDG	Sustainable Development Goal
SWEEP	State Water Efficiency and Enhancement Programme (SWEEP)
UNFCCC	United Nations Framework Convention on Climate Change
WII	Weather-based Index Insurance
ZFU	Zimbabwe Farmers Union

CHAPTER 1 INTRODUCTION

1.1. Background

Climate variability and change have gained attention globally because of the significance of their impact and threat to climate-sensitive sectors, that include agriculture, energy, water, tourism and fisheries. The threat to the agricultural sector and non-agricultural livelihoods, food security, poverty and development at community and macro levels are highlighted by the Intergovernmental Panel on Climate Change (IPCC). The IPCC (2018) defines climate change as the alteration in the state of the climate that is recognisable by the shift of the mean and variations in the properties of the climate over a prolonged period that can extend to decades or more. Climate variability and change alter ecosystems, hydrology and water resources, food and fiber production (IPCC, 2022). The drivers of climate change include those instigated by natural factors, as well as the direct and indirect effects of human actions. Human actions that contribute to climate change include deforestation, burning of fossil fuels, industrial production, use of agrochemicals, production of livestock, and poor soil and water management (Mikhaylov *et al.*, 2020; Mihiretu *et al.*, 2021). Climate variability and change have created conditions of vulnerability to farming systems because of rising temperatures, increasing frequency of heatwaves and distortion of rainfall patterns, with consequential effects on incidences of crop and livestock diseases, flooding, strong winds, cyclones, droughts, rising sea levels, as well as diminished soil moisture and fertility. The frequency and intensity of the incidences create risks and ambiguities for smallholder farmers (Khan *et al.*, 2022).

Projections are that the Southern Africa region has a high probability of experiencing heat waves, rise in temperatures, reduction in the occurrence of cold extremes, medium confidence in the intensity of droughts, change in rainfall patterns, and an increase in evaporation and plant transpiration (Davis-Reddy & Vincent, 2017). Historical projections indicated that by 2050, Southern Africa, Zimbabwe included, would have experienced a 3 to 6° C increase in temperature, a fall in reliable crop production days to less than 90, and 5 % fall in annual rainfall (Jones and Thornton, 2009; Niang *et al.*, 2014, cited by Descheemaeker, 2018; Brazier, 2015, cited by Dondo, 2020). In Zimbabwe based on historical and future 2050 projects indications are that the average monthly temperature for all Provinces will increase by 1.8 % (Hunter *et al.*, 2020). According to Hunter *et al.* (2020) the highest increases, of between 2 and 2.7 %, are expected in the October to November. In the observations of Hunter *et al.* (2020) complicating the situation for the country is that predictions for significant reduction in the total amount of monthly rainfall will be between October and November from 24.4 to 10.6 mm and 73.9 to 54 mm respectively. In Africa, the extreme day temperatures are associated with lowering of crop yields and shortages of water that may cause negative changes to the types, timing, scale of crop and livestock

production (IPCC, 2014; *Dube et al.*, 2016). The seasonal calendars for productive activities might be disrupted, with some shorter than usual, and likely to reduce crop productivity and incomes. In Zimbabwe, the period anticipated for the changes in surface temperature and rainfall coincides with the peak of the agriculture planting season when there is high demand for crop water. According to Hunter *et al.* (2020) temperature and rainfall changes will by 2050 result in an annual loss of 230,000 tonnes of maize which will require a replacement cost estimated at US\$89 million. Studies in Mashonaland and Masvingo Provinces of Zimbabwe indicate that climate induced factors have already caused disruptions to agriculture livelihood systems with negative effects on all dimensions of food security, including food access, stability, availability, and utilisation (Maireva, 2023; Muzerengi *et al.*, 2023; Mpala & Simatele, 2024).

In Southern Africa, agriculture is climate-dependent and sensitive yet an important economic sector, contributing between 4 to 27 % of the Gross Domestic Product (GDP) in some countries and with a large part of the population relying on the sector for livelihoods including food, jobs and income (Bekun & Akadiri, 2019; Dzama, 2016). In Zambia and Mozambique, the share of agricultural sector to the countries' GDP is 8.2 % & 25%, respectively (Braimoh *et al.*, 2018; International Finance Corporation, 2021). In Zimbabwe, agriculture plays an important role to the economy with an estimated 12 to 18 % contribution to the country's Gross Domestic Product (GDP). The sector has a 23 % share of formal employment and in rural areas 70 % of the population depends on agriculture for employment and livelihoods (Ministry of Agriculture, Mechanisation, and Irrigation Development, 2013; World Bank, 2017; African Union, 2023). Zimbabwe's agriculture sector experienced growth from a negative in 2019 to 4.1 % in 2020, 17.5 % in 2021, falling to 4.9 % in 2022, and rising to 7.1 % in 2023 and a projected decline to -15 % in 2024 (African Union, 2023; World Bank, 2024). According to the African Union (2023) and the World Bank (2024) the fall in the growth of the agriculture sector in 2022 and that projected in 2024 is associated with the occurrence of droughts. Human actions are attributed to the increased global warming and consequential frequency and intensity in the occurrence of El Nino and associated droughts (World Bank, 2024). The drought is projected to significantly cause negative growth in wheat, maize and tobacco production in the 2024/25 harvest (World Bank, 2024). According to the World Bank (2024) to cover the food gaps caused by periods of fall in production an increase has been observed in maize and other food imports (World Bank 2024). Developments in the country's agriculture sector impact other dependent economic sectors. This is because estimates are that in the industrial clusters 15 out of 31 entities rely on agriculture feedstock (African Union, 2023). In addition, agriculture supplies 63 % industrial raw materials and has a 60 % share in manufacturing value addition and 30 % of export earnings (African Union, 2023). Beyond the ramifications to agriculture climate variability is viewed impacting other sectors such as hydro-electricity energy generation (World Bank, 2024).

The risks and impact associated with climate variability and change on agricultural livelihoods and food security inspired the promotion of adaptive measures commonly called Climate-smart agriculture (CSA) practices. The practices encompass an assortment of technologies and approaches that can be implemented as stand-alone or in combination, in response to experience and anticipated effects of climate change. The CSA practices include farm-level land and financial management practices, enhanced technologies, government and private sector programmes and services. CSA practices such as crop intensification, conservation agriculture, contour ridges, mulching, zero tillage, micro-irrigation systems, improved fallows, weather index insurance, as well as improved input varieties, have been implemented in Mali, Mozambique, Malawi, Mali, New Zealand, Zambia, Kenya, Ghana, Zimbabwe and other countries. In different contexts where CSA practices have been promoted, they demonstrated significant positive results that include restoring and increasing farm production, improving soil fertility, reducing the use of water, greenhouse gas emissions, and operating costs with significant impact on increasing productivity and incomes of the farmers (Aune *et al.*, 2017; Mango *et al.*, 2017; Partey *et al.*, 2017; Musvoto, 2019). However, despite the positive impact, some practices have not demonstrated sustainability beyond programmes, uptake has been localised and not reached many farmers and drop-outs have been experienced. Questions have been raised on what influences both the adoption and continued application of CSA practices in several countries including Guatemala (Phuong *et al.*, 2018; Mase *et al.*, 2017) and South Africa (Smith *et al.*, 2017). The reasons attributed to low adoption of CSA practices are varied, but include weaknesses in supportive institutional and policy frameworks, the demographic profile of the farmers, inadequate resources, incompatibility of technologies to contexts, high transaction costs for accessing the technologies, as well as limited data and lack of access to information (Williams *et al.*, 2015; Sibiko *et al.*, 2018; Teame & Hagos, 2019). However, there is a lack of consensus regarding the influence of some drivers for adoption, as in some instances, they have been observed to obtain different adoption behaviour outcomes by farmers. Illustratively, in some cases, the education levels of the farmers are associated with influencing positive adoption behaviours while in others, this had no influence (Khan *et al.*, 2022; Nyengere *et al.*, 2016; Kassa & Abdi, 2022; Okumu *et al.*, 2023).

The interest of this study is to understand the farmer household risks that influence their risk perception and decision-making when adopting CSA practices. In most literature on the adoption of CSA practices, there is limited clarity and consensus on the role of household risks in risk appraisal and subsequent adoption of adaptation behaviours by farmers. The study aims to characterise household risks as perceived by smallholder farmers and determine whether they influence risk perception and decisions to adopt adaptation measures. The research is motivated by Mase *et al.* (2017), who argue that agricultural systems are not vulnerable to just the effects of

climate variability and change, but also the behaviours of the smallholder farmers. In this context, understanding what influences the behaviours of the farmers becomes an important area for research focus. The study was undertaken in Zvimba District of Zimbabwe, where according to Mashizha (2019) communities have already experienced the effects of climate variability and climate change that include alterations in the rainfall pattern, occurrence of droughts, increase in temperature and outbreak of animal and crop diseases. These effects are already associated with changing cropping practices and productivity. The study thus involved 87 farmers who accessed integrated CSA practices that included access to agronomic tips and weather information, discounts on agricultural inputs, promotion of drought-tolerant crop inputs and livestock varieties, maize and livestock information tips, funeral cover, as well as weather-based Index Insurance (WII).

1.2. Statement of the research problem

In the absence of sustained and scaled human adaptation to climate change food and agriculture systems are under threat with consequential negative impact on food and nutrition security. An estimated, 691 to 783 million people globally were food insecure in 2022, with no signs of measures to effectively immediately and significantly address the situation (Food and Agriculture Organization, 2024). In Zimbabwe the 2023 Zimbabwe Vulnerability Assessment Committee (ZimVAC) estimates were that in early 2024 both urban and rural areas had a combined 4.2 million people that were food insecure (WFP, 2024). The annual cereal production for Zimbabwe has been falling and not meeting requirements. An analysis by Moyo (2024) showed that the annual cereal requirements for the country were 1.4 million tonnes while harvests were 777,000 and 908,000 in 2019 and 2020 respectively. If food production trends do not change, the global and national demand for food will not be met. A significant increase in the production of crops is demanded if global food availability is to be assured. In the 2030 Agenda for Sustainable Development Goals, hunger and food insecurity are highlighted as global challenges that must be addressed within the context of increasing urbanisation, population growth, and competing use of land. The efforts to increase food production have encountered the constraints imposed by climate variability and change on food and agricultural systems.

In Zvimba District of Zimbabwe the Scaling-up Climate-Smart Agriculture Solutions for Smallholder Farmers in Zimbabwe (CSS) programme was designed by Zimbabwe Farmers Union (ZFU) to contribute towards increasing productivity and adaptation of the agricultural sector in the context of climate change. As part of the programme design, the analysis of the risk context identified inconsistency and unpredictability of rainfall patterns that disrupted planning and decision-making and livelihoods of the smallholder farming sector. Compounding the situation was the observed lack of access to information, use of unimproved agriculture input varieties, and

lack of diversification of production systems. Also, the analysis acknowledged that CSA practices had already been implemented in the country but lacked access to platforms for effective dissemination to create awareness and scale adoption by farmers. The CSS programme was therefore designed to address the four main challenges of smallholder farming systems that included the uncertainty in weather patterns, lack of awareness of adaptation measures, use of unimproved input varieties, and lack of diversification of production systems. The two components of the CSS programme that responded to the uncertainty of weather events were weather insurance and weather information service. Area-based Weather Index Insurance (WII) was provided to farmers covering risks such as the failure and loss of crops because of weather events such as droughts. Farmers would be compensated for loss of crops, which they could not do before the programme. The insurance pay-outs would support the farmers to meet their consumption needs and restore production for the next season. The programme regularly provided smallholder farmers with information alerts on anticipated weather patterns such as the likelihood of rains, storms, and high or low temperatures. The farmers were encouraged and expected to use this information in planning and decisions on their household and farm actions which they would not do before the programme. To address the lack of awareness of CSA practices, the programme used information and communication technologies (ICTs) to disseminate information on farming tips. Through mobile phones and complemented by agricultural extension workers, the farmers were provided with tips relevant to the management of crops and livestock including feeding, vaccination, and disease management. To better respond to inconstant rains, the farmers were encouraged to use drought-tolerant crop input varieties. ICTs were used to disseminate information tips on the types of inputs, advantages, and production methods to ensure those adopting increased productivity despite threats from moisture-stressed conditions. The programme promoted and improved livestock production to support the diversification of smallholder farmer livelihoods beyond crops. The programme design phase noted how smallholder farmers used livestock to mitigate risks and restore production. Improving the types and quality of livestock would increase incomes and resilience to climate-induced stressors such as outbreaks of diseases. To access these services, the smallholder farmers were required to have ZFU membership, which would unlock other benefits that included buying agricultural inputs at discounted prices from pre-selected agro dealer retail outlets. Farmers could also access funeral insurance that would cover expenses in the event of the insured dying. It is these multiple services that were bundled to make-up the combo product promoted by the CSS programme in ten districts of the country. The bundled services were available to farmers at a cost of United States \$1 per month. Though smallholder farmers bought the bundled services, they chose to use only those most appropriate to their needs.

The CSS programme was implemented in the background of mixed experience with sustained and scaled adoption CSA practices. The low adoption rates and limited sustainable implementation by smallholder farmers raise questions on whether enough is known on what drives the decisions of farmers to adopt, scale up and sustain the implementation of adaptation measures. The inability to address the correct drivers of adoption could result in exacerbating the contribution of human actions to climate variability and change. This is likely to further cause the deterioration in the vulnerability and poverty status of communities whose livelihoods are dependent on agriculture. In addition, the knowledge gap could result in the failure to develop policies and programmes that sufficiently address the needs of smallholder farmers, the achievement of development goals, and contain the effects of climate variability and change. Consequently, the state of global and national food availability could continue to worsen, increasing the number of hungry people. It is in the context of the above, that this study envisages to explore the experience of smallholder farmers in Zvimba District when they adopted the combo product.

1.3. Justification of the study

Projections indicated the imperative for a significant increase in supplies of cereals, fruits and vegetables (Sun *et al.*, 2020). This is achievable if food and agricultural systems are thriving to levels that surpass the global demand for food. The effects of climate variability and change stand in the way of efforts to increase food production and availability. The promotion and adoption of CSA practices at scale is a necessary policy and programmatic response to actual and predicted effects of climate variability and change on food and agriculture systems and development. There are CSA practices that have demonstrated positive contribution to increasing productivity and incomes, reducing greenhouse gas emissions, and building resilience. It is therefore apt to find ways how the adoption of such practices can be sustained and adopted at scale. Precision nutrient application and irrigation methods have increased effective use of agricultural inputs that in turn increased productivity and economic returns (Schimmelpfennig, 2016; Balafoutis *et al.*, 2017; Nyagumbo *et al.*, 2019). The pay-outs from Weather Index Insurance (WII) supported farmers in restoring assets and recording more secure food security status after crop failures and increasing the size of cropping land (Bertram-Huemmer & Kraehnert, 2018; de Janvry *et al.*, 2016; Michael *et al.*, 2018). Efforts should be made to reduce the incidences of low adoption of CSA practices that have been observed in other contexts. Results from some CSA programmes have shown that despite very high levels of awareness, adoption rates were low, and questions have been raised on the sustainability of the practices in the absence of incentives (Peterson, 2014; Sain *et al.*, 2017; Smith *et al.*, 2017; Lan *et al.*, 2018; Phuong *et al.*, 2018). In some contexts, the drop-out of farmers after adoption of CSA practices has been recorded (Arce, 2016; Njue *et al.*, 2018). The low pattern of adoption is a concern for policymakers, researchers, programme

implementers, and smallholder farmers, considering the financial, time and human resources committed to promote and implement the adaptation measures.

The study was undertaken in the background of the dilemma of high-impact and low-adoption trends of CSA practices. Knowledge has been generated on possible drivers of adaptation, but the value has not been demonstrated by more positive change in the pattern of adoption. The farmer household factors that have been associated with influencing adaptation decision-making include their age, education, income and farming assets (Khan *et al.*, 2022). While acknowledging the relevance of these factors, the study challenges the level of application and their adequacy. The factors are applied at the level of adopting the already developed CSA practices, but do not seem to have a place at the level of risk shaping and risk appraisal. The study sought to find out from the smallholder farmers the types of risk factors in their environment and examining whether they influenced risk, and adaptation appraisal and decision-making. The study provides insights into whether deeper analysis should consider household circumstances with risk implications on smallholder farmers. The study thus contributes to existing knowledge on understanding the drivers of risk appraisal and adaptive capacity appraisal, and their influence on smallholder farmer decision-making in adopting CSA practices. This improves the knowledge of the types and quality of public and private sector services and actors that are necessary and appropriate for smallholder farmers exposed to adaptation measures with the intent to increase the scale and sustainability of adoption. The findings from this study might benefit farmers, policymakers and programme implementers, researchers, and the private sector involved in agriculture, food security, climate variability, change, development, and poverty.

The contribution of this study towards efforts to increase the scale of adoption and sustainability in the implementation of CSA practices is imperative to agricultural livelihood systems and development in Zimbabwe and other countries where adaptation measures are promoted. If more farmers can use proven practices, this may increase the chances to contain and adapt to the effects of climate variability and change.

1.4. Research objectives

The aim of the study is to identify the drivers of risk perception that in turn influence risk and adaptation appraisal and decision-making by smallholder farmers when adopting CSA practices in rural Zvimba District of Mashonaland West Province, in Zimbabwe. The specific objectives and associated research questions that are addressed by key informant interviews, FGDs and a survey are as follows:

1. To characterise the climate change and household risk context of smallholder farmers in Zvimba District
 - a. What is the description of climate change risks that smallholder farmer households experienced in Zvimba District?
 - b. What is the description of household risks that smallholder farmers experienced in Zvimba District?

The purpose of Objective 1 is to profile the climate change and household risk context of smallholder farmers at the time the CSS programme was launched. This is accomplished by inquiring, through Focus Group Discussions and a household survey, the types of climate change and household risks experienced by smallholder farmers.

2. To assess the influence of household risks on farmer decision-making in the adoption of the combo product in Zvimba District
 - a. Can the influence of climate change risks in the adoption of the combo product be validated?
 - i. Did climate change risks influence the decision of the smallholder farmers to adopt the combo product?
 - b. What influence did household risks have in the adoption of the combo product by smallholder farmers?
 - ii. Did household risks influence the decision of smallholder farmers to adopt the combo product?
 - iii. How did smallholder farmers associate household risks with the adoption of the combo product?

The findings from Objective 1 would be used to further explore issues under Objective 2. The purpose of Objective 2 is to validate the already known influence of climate change risks and establish whether the household risks influenced smallholder farmers to adopt the combo product.

3. To determine the scope of household risks impacted by the combo product among smallholder farmers in Zvimba district
 - a. What pre-existing household risks were impacted by the adoption of the combo product in Zvimba District?
 - i. What household risks were impacted by the combo product?
 - ii. What is the likelihood to continue using the combo product?

The purpose of Objective 3 is to establish which of the household risks that farmers had before the launch of the CSS programme were impacted by the combo product. The study established whether there was an alignment between the household risks they had and the effects they experience from the adoption of the combo.

1.5. Theoretical framework of the study

To understand what influences smallholder farmers to adopt adaptation measures, such as the combo product, the study drew on select aspects of Grothmann and Patt's (2005) Model of Private Proactive Adaptation to Climate Change (MPPACC) shown in **Error! Reference source not found.** The model was selected for its application at the level of the individual farmer who is a key factor in responses to climate change, and whose actions have a significant contribution to the effectiveness of adaptation measures. It was therefore imperative to understand the climate change and household factors that obtained before the launch of the CSS programme and how these could have influenced the response of smallholder farmers to the CSA practices that were being promoted.

The MPPACC model provides a process-based explanation of the socio-cognitive perception of risk that underlies farmer-level adaptation behaviours in response to the effects of climate change (Buelow & Cradock-Henry, 2018). The inclusion of process in the model accommodates the evolving nature of a farmer's appraisal and decision-making behaviour as they interact with risk. The three major process elements in the model are risk appraisal, adaptation appraisal, and adaptation decision-making. As Khan *et al.* (2022) argue in the MPPACC, climate change risk appraisal is the foremost step taken in the adaptation decision-making process by farmers. Risk appraisal entails an individual assessing the prospect of a real or anticipated threat or hazard occurring and anticipation of the probability of damage to what they value if no adaptive behaviour is taken. In each context, the things that farmers value are diverse and may include food and income security, good health, education access, shelter, crops and livestock. What each farmer values could depend on several factors including family status, education levels, vulnerability status, ownership of financial and physical assets and exposure, among others.

The outcome of risk appraisal is risk perception, and that can result in two possible sub-outcomes that are perceived probability and perceived severity. In the MPPACC, the perceived probability relates to a farmer's determination of the likelihood of them being affected by an anticipated threat according to Grothmann & Patt (2005). The perception of the probability and effects can be influenced by several factors such as information available, experience of the farmer with past shocks, agriculture extension services, weather information services, radio and social media, knowledge and social discourse within the circles of farmers (Grothmann & Patt, 2005; Mitter *et*

al., 2019). Globally, and in Southern Africa in particular, the effects of climate variability and change are already being experienced (Nhemachena *et al.*, 2020; Ramirez-Villegas *et al.*, 2021). Agricultural livelihoods have persisted through seasons of diverse climate events with varying impacts on productive activities, this may influence farmers to be always thinking about probable scenarios. The study validated whether farmers had awareness and experience with the effects of climate change within their context. The knowledge and experience assured the presence of an appropriate environment with threats that would have ideally triggered farmers to initiate the adaptation process (Khan *et al.*, 2022). This may imply farmers already had knowledge and experience of certain shocks and threats.

The type and intensity of information shared on climate threats through various platforms may further influence the perception of farmers on the probability of the threat occurring and the likelihood of being affected. The perceived severity relates to a farmer speculating the extent of damage in the event of an anticipated threat occurring. The farmer considers how, and to what extent each of what they value will be affected by the external threat. Access to information and experience with similar events, and how they disrupted communities could be a basis for farmers to estimate severity. Farmers could recall how past disasters destroyed asset bases, harvests, food reserves, and income. The determination of the effects, whether positive or negative, would motivate farmers to frame particular risk perceptions to the climatic threat. The farmer's perception of the severity of the damage would be important in determining their capacity to adapt.

Adaptation appraisal, which succeeds risk appraisal, entails an individual's self-assessment of their ability to take preventative action against the negative effects of climate change and the determination of the nature of costs and benefits associated with the chosen adaptive action. Three relevant elements of adaptation appraisal include perceived adaptation efficacy, perceived self-efficacy, and perceived adaptation costs. The concept of perceived adaptation efficacy refers to the level of confidence that an individual farmer has in the extent of the effectiveness of an adaptation measure to prevent or mitigate the damage effects of a threat (Nyboer *et al.*, 2022). Farmers may consider the information that they receive about an adaptation measure to determine how their concerns with climate change would be prevented or mitigated. A high level of confidence that an adaptation measure reduces the adverse effects of a threat would influence the farmer's perception towards adoption (Khan *et al.*, 2022). Perceived adaptation efficacy can be a useful concept in understanding sustainable adoption by farmers, particularly beyond programme implementation phases. If an adaptation measure was perceived to prevent or mitigate the effects of a threat, the farmer would be motivated to continue using it. Perceived self-efficacy is the confidence of a farmer in their ability to practice the required adaptation behaviours in response to the perceived effects of a threat (Angill-Williams & Davis, 2022). Farmers may

access different CSA practices but lack the capacity necessary for them to apply and benefit from the technologies. The factors that could influence perceived self-efficacy include experience, skills and knowledge, and the farmer's age and education level, among others. A high level of confidence in the ability to use an adaptation technology or behaviour could influence positive adoption perception. Through understanding the self-efficacy of farmers, measures can be taken to strengthen their adaptive capacity to prevent and mitigate their vulnerability to climate change.

In the MPPACC, perceived adaptation costs influence the decision to adopt CSA practices. The perceived adaptation costs are the material and non-material costs that are likely to be incurred because of adopting an adaptative measure. The scope of the costs is multi-faceted to include social, economic, physical and psychological. The level and nature of costs for adopting an adaptation measure might influence the adoption decision. Farmers, among other things, also consider the costs they incur to access CSA practices, the practical benefits of using the adaptation measure, the usefulness of CSA to day-to-day needs, the changes CSA brings to productivity and incomes, and the time that they spend participating in the activities. Khan *et al.* (2022) posit that the adoption of adaptation measures by farmers is predicated on their determination of associated expected benefits within the context of anticipated climate change effects. The determination of the likelihood of positive benefits would create conditions for the adoption of adaptation measures. An individual sets a minimum level of tolerance of the costs associated with a threat, which, if exceeded, prompts their consideration of adaptation actions and the ability to act. High costs may be a disincentive for adaptation, while low costs may trigger a positive response.

In the MPPACC, cognitive biases influence the perceived adaptive capacity of farmers. A cognitive bias relevant to this study occurs when individuals determine their adaptive capacity by referring to the occurrence of the same shocks in the past. A meta-analysis by van Valkengoed and Steg (2019) concluded that experience with natural shocks influences positive adaptation behaviours. The study location had already experienced the effects of climate change and farmers had experience implementing CSA practices. The study setting had features appropriate for activating risk experience appraisal, which, according to Grothmann and Patt (2005), has the likelihood of influencing the cognitive biases of individuals, preparedness and adaptative behaviours. Farmers in the study sample had practical evidence on how shocks affect the things they value most, how they adapted and the costs they incurred during adaptation. In the study sample, the farmers could use the experience to assess their objective adaptive capacity and efficacy, having used all and specific elements of the combo product promoted by the CSS programme. Cognitive bias can be shaped by the participation of individuals in social networks or

groups and information they access through various platforms, all of which influence their perception of risk and adaptive capacity.

The objective adaptive capacity in the MPPACC relates to what farmers may be endowed with, or lacking, in terms of knowledge or skills required to implement a given adaptation measure. The range of endowments or capabilities of farmers are diverse, and each will likely have varying levels of significance in their influence on perception and action. Farmers consider the enormity of the climate change threat to determine their objective adaptive capacity. Grothmann and Patt (2005) argue that an individual's determination of the objective adaptive capacity directly influences their adaptation behaviour. As an illustration, a climate threat may require a certain level of financial resources that is beyond what a farmer owns, or can access, which could result in limited objective adaptive capacity and concurrently failure to adapt. The intent to adopt may be lower where the objective adaptive capacity is limited or not guaranteed during adoption.

In some CSA programmes, incentives are provided to stimulate adoption by farmers. The incentives can be material or non-material and can either be free or subsidised for the end user. In the CSS programme, discounts when buying agricultural inputs are an example of incentives that the farmers could access. The MPPACC considers incentives to have dual roles of being an added motivation for adoption or being a direct motivator for adoption. However, there are alternative views where incentives alone are viewed as not adequate to motivate farmers to shift from intention to actual adoption (Buelow & Cradock-Henry, 2018). Figure 1-1 illustrates MPPACC model.



Source: (Adapted from Grothmann & Patt, 2005)

In the decision-making process, Grothmann and Patt (2005) distinguish adaptation intention and actual behavioural adaptation. The reasoning is that in some instances, individuals have the desire to adopt adaptation measures, but may encounter practical constraints that inhibit actual adoption, which they refer to as objective adaptive capacity. Despite the separation, adaptation intention is a necessary state that precedes actual behavioural adaptation.

There is a lack of clarity in the MPPACC, on the breadth of threats that instigate risk appraisal. The threats that trigger risk appraisal are largely regarded as extrinsic to the farmer and these include factors related to changes in rainfall, temperature, disease and wind patterns. The social characteristics of farmers are particularly considered for how they could determine vulnerability to threats, how they could be damaged by the threats, and their influence on capacity to respond to threats. It is not clear whether the things that farmers value and fear could be disrupted, could on their own be considered as potential instigators of risk appraisal and risk perception. As an illustration, if a farming household is experiencing food insecurity and this imposes imminent danger to the well-being of their families, it is not clear if this may likely be a motivating factor to the adoption of measures to mitigate or prevent this vulnerability. This may occur with or without climate variability and change. It may be possible that the adoption of climate change adaptation measures that are deemed to have the efficacy to increase food production and improve food access may in some instances be motivated by the appraisal of the threats of food and nutrition insecurity. This may hold substance, given what ensues in the food and nutrition insecurity and HIV/AIDS nexus, with the former having been observed as a driver of risky behaviours such as low negotiation power in a sexual relationship and high sexual risky behaviours, particularly for women (Onono *et al.*, 2021). In this line of argument, it is pertinent to consider the probability of the farmer household risks to have an equally influential role to be perceived as threats that merit risk appraisal by farmers. This may require an appreciation of the convergence of climate change shocks and what the farmers value as having the same effect of being drivers of risk appraisal and perception. Where this happens, the farming households will have two risk drivers concurrently affecting risk appraisal and perception. In **Error! Reference source not found.** what is labelled as the underlying risk drivers represents the survival imperatives that have not been widely documented for their influence in adaptation decision-making. Whether these are drivers of risk perception or the things that farmers value most is what the study determined.

1.6. Operational definitions of key terms and concepts

Adoption: This is the application by a farmer, over a protracted period of a new idea or innovation that they determined as the best from available options, including what they might have already been using (Miranda *et al.*, 2018). The process of adoption is rooted in Rogers's diffusion theory where five interrelated phases include awareness, interest, evaluation, trial, and adoption

(Nkonki-Mandleni *et al.*, 2016; Mohammadi *et al.*, 2018; Pannell & Claassen, 2020). In the awareness phase, the user is not knowledgeable but receives information on the challenges and innovations available. The nature and form in which the information is shared with the user will potentially generate the second phase of interest in the innovation. The information shared and interest generated, the current situation and the anticipated future allow the user to shift to the next phase of evaluating the innovation. The results will lead to trying out the idea and the possibility of adoption if expectations are met.

Climate-smart agriculture (CSA): Farming practices that are promoted to improve the capacity of food and agriculture systems to adapt and mitigate the effects of climate change while contributing to food and nutrition security and assuring more sustainable development (FAO, 2018). The range of interventions that contribute to these outcomes includes diversifying the farm economy, nutrient and soil management, use of improved agriculture input varieties, adoption of efficient irrigation and water management methods, access to climate and agriculture information, access and availability of farm insurance, protection of forests/agroforestry, protection of contours, changing cropping calendars, crop or livestock intensification, crop and livestock integration, cover cropping and crop rotation, intercropping and value chain development (Sibanda *et al.*, 2017; Smith *et al.*, 2017; Whitfield *et al.*, 2018). There is convergence between CSA practices and some approaches implemented in the past, such as sustainable agriculture and/or environment management and conservation agriculture.

Combo product: The services that were packaged together and offered as one product to smallholder farmers under the CSS programme. The services comprised funeral cover, membership to ZFU, discounts when buying agricultural inputs, access to drought-tolerant inputs, promotion of livestock products, access to weather information, maize, livestock information tips, and Weather Index Insurance (WII). The monthly premium for the combo was United States \$1 per month per farmer.

Risk: As applied in this study, risk refers to the future probability of a household being in a situation where they lose the capability to meet a livelihood need or obligation that may be predictable or unpredictable and with consequences on those affected. Šotić and Rajić (2015) highlight the diverse and contentious views on risk, but they draw out some key and relevant features associated with the concept, including being about the future, implying uncertainty, having consequences, and as a social construct. In this study climate change risks are used to refer to the adverse disruptions to smallholder farmer agriculture based livelihoods that are caused by among others the occurrence and intensity of droughts and flooding, temperature

extremes and increases, and variability in precipitation, (Davis-Reddy & Vincent, 2017; Mashizha, 2019). Household risks are used to refer to adverse disruptions and stresses that are caused to the well-being of households because of food and nutrition insecurity, unemployment, illness and death in families, lack of access to input and output markets, high and unaffordable prices of goods and services, outbreak of crop and animal pests and diseases and death of livestock.

Risk consequences: The incidental disruptions, loss or damage that arise directly and indirectly following the impact of a shock on households. Individuals identify and associate consequences that their households may experience and analyse to draw out perceptions on the state of their household livelihoods. The consequences may include inadequacies in access to food, malnutrition, health, education, shelter, and other well-being needs of the household. These factors may be considered in the context of their interplay with multiple characteristics of households such as household size, age, gender, social networks, types and number of income sources, location, access to and status of employment, and access to compensation after loss (Assaf & Pullum, 2018; Klapper *et al.*, 2019).

Scale: is used to refer to 1. increasing the number of farmers that adopt CSA practices for greater impact (scaling up); 2. the ability of CSA practices to influence transformation and application of climate smart institutional and policy frameworks allowing for replication to other farmers and environments (scaling out) and 3. the ability of CSA practices to influence change in the cultural beliefs, values and norms of farmers (scaling deep) (Riddell & Moore, 2015; Bolzan *et al.*, 2019)

Smallholder farmers: In Zimbabwe these are communal farmers who live in villages and have their livelihoods based on cropping and common livestock grazing land that range between 2 to 20 hectares (Ministry of Lands Agriculture and Rural Resettlement, 2018; ZimStats, 2019; Chambati & Mazwi, 2020).

Sustainable adoption: This occurs when an innovation adopted by a smallholder farmer is repetitively practiced and realising the intended outcomes. Pannell & Claassen (2020) argue that adoption can be both variable and alternating for the same farmer. Variable adoption is where the technology is fully or partly utilised. In alternating adoption, the farmer uses the technology at some periods and stops doing so in others, depending on the appropriateness to prevailing context such as climatic factors. When the farmer can determine the appropriateness of what and when to apply a technology, the adoption is still sustainable.

1.7. Outline of the research thesis

The thesis has five chapters. In Chapter 1 the background to the research topic and context is outlined, including a statement on what is the research problem and the justification for conducting the study, and the objectives of the study. The research questions that are answered by the research, the theoretical framework that informs the scope of the study, and key terms and concepts relevant to the study are defined. Chapter 2 presents the literature review related to the research topic, including the state of global food needs and crop production and how the latter is affected by climate variability and change and the adaptation measures that have been implemented in response. Specific attention is given to CSA practices and how effective they have been implemented, including the key questions on their ability to reach scale and be implemented with sustainability. Chapter 3 describes the research methodology that was used. Chapter 4 includes a presentation of both the quantitative and qualitative findings from the research. The final Chapter 5 discusses the findings, outlines some of the implications for practice, and areas recommended for further research.

1.8. Chapter summary

A significant proportion of the global population was hungry in 2020, with the risk of persistence if food production trends do not change. Increasing urbanisation, population growth, and competing use of land add pressure on the global demand to increase food production. The impact of climate variability and change on diverse economic sectors, poverty, and development drives the global prominence of the phenomenon. Climate change caused by a combination of natural factors and human action disrupts ecosystems, hydrology and water resources, food, and fibre production creating conditions of vulnerability to farming systems, with severity in the Southern Africa region. Agriculture is an important economic sector in Southern Africa, given its contribution to the Gross Domestic Product (GDP), employment and livelihoods in the region. CSA practices have been promoted as a response to the risks and impact associated with climate variability and change on agricultural livelihoods and food security. The CSA practices include farm, soil, financial, input, and land management practices and policy frameworks that, in different country contexts, have demonstrated positive impact in restoring and increasing farm production, improving soil fertility, reducing the use of water, greenhouse gas emissions, and operating costs. The positive impact of CSA practices has not been complemented by scale and sustainability in adoption by farmers, raising questions on what drives adoption. The drivers of adoption are variously considered to include the presence of institutional frameworks, the profile of farmers, access to resources, technology, information, and transaction costs. There is a lack of consensus on the influence of farmer household factors on adoption decision-making. The study aimed to identify what drives risk perception and influences adaptation appraisal and decision-making by smallholder farmers when adopting CSA practices using a sample of farmers in the rural Zvimba

District. The three objectives for the study related to 1) characterising the risk context of farmers, 2) examining the association between the risk context and adoption of the combo product, and 3) demonstrating the scope of household risks impacted by the combo product. The Model of Private Proactive Adaptation to Climate Change (MPPACC) was used in framing the study. The MPPACC provides a process-based explanation of the behaviour of farmers in response to the effects of climate change. The response of farmers to climate change is viewed as transitioning through three interrelated processes: risk appraisal, adaptation appraisal, and adaptation decision-making.

CHAPTER 2 LITERATURE REVIEW

2.1. Introduction

The current and future state of food systems is under threat from multiple and dynamic effects of increasing urbanization, population growth, food price volatility, climate change, degradation of environment and water resources, and increasing wealth and changing consumption patterns. Food systems transformation provides a framework for comprehensive, dynamic, equitable and sustainable response to addressing the enormity of country, regional and global agriculture, climate change, environmental, food and nutrition, health and development threats, challenges and aspirations (Pingali & Abraham, 2022; Sonnino, 2023). According to the International Fund for Agricultural Development (2021) there are five domains that influence the transformation of food systems, and these include the biophysical and environmental, technology and infrastructure, political and economic, sociocultural, and demographic. Attention within and across each domain is imperative to achieve the objectives of food systems transformation that include positive and resilient outcomes in nutrition, livelihoods, and environment (International Fund for Agricultural Development, 2021; Dengerink *et al.*, 2022). The biophysical and environmental domain includes climate variability and change whose effects and responses are the interest of this study. The state of and threats to agriculture and food systems underly the promotion and attention on CSA practices and the pursuit to understand and address the issues of scale and sustainability in the adoption of adaptation measures. The success or failure of CSA practices must be appreciated beyond the technological approaches to the interconnectedness and impact on food and agriculture systems. The promotion of CSA practices is meant to strike a balance between containing the effects of human practices on climate change, reducing the effects of climate change on food and agriculture-based livelihood systems, restoring losses, addressing some of the drivers of poverty, and maintaining and increasing the pace of food production in the face of growth in global demand for food.

Adoption of CSA practices at scale is a necessary policy and programmatic response to actual and predicted effects of climate variability and change on food and agricultural systems and development. The positive results from the implementation of CSA practices have been accompanied by low adoption rates and questions on how to sustain and scale up some of the successful practices. This dilemma has generated interest from policymakers, researchers, and programme implementers on the factors that drive the risk perception of farmers and their decision not just to adopt, but also to implement CSA practices with sustainability. The perspectives on the drivers of risk to farmers have been diverse, including environmental, market, production,

technology, financial, human and institutional domains (Meraner & Finger, 2018; Duong *et al.*, 2019).

The farmer household risks are not prominent as drivers of risk that instigate households to initiate the risk appraisal processes. There is limited knowledge on whether household risks could drive risk perception with an influence on adoption decision-making processes. The farmer-level characteristics are largely applied on their interplay and influence on the adoption of CSA practices. When CSA practices are launched, the drivers that influence adoption are generally classified into three broad but interrelated categories: household or farm, system, and technology level. There is a likelihood that not one, but a combination of factors across these categories, influences the adoption behaviours of farmers.

The interest of this study is to understand the household risks of farmers and their association with what drives risk perception, and the consequential influence on adaptation decision-making on CSA practices. The chapter reviews the literature on global trends on the state of the demand for food crops, food and nutrition security, and an overview of the effects of climate change on crop production. It also presents the significance of adaptation in responding to climate variability and change, as well as some of the CSA practices that have been implemented in different parts of the world. It also reviews the positive impact of CSA practices and the challenges with scale and sustainable implementation. In addition, the chapter provides an overview of the factors that influence the adoption of CSA practices. The final part of the chapter gives a synopsis of the area where more research might be needed, about household risks and how they could shape risk and adaptation appraisal and decision-making in the adoption of CSA practices.

2.2. Global food needs and crop production

The 2030 Agenda for Sustainable Development includes the Sustainable Development Goal (SDG) 2 which aims to address four core challenges of development: hunger, food security, nutrition and sustainable agriculture. The SDG priorities are underlined by the need to take measures that will address the challenges of food availability in a context characterised by current and future food and nutrition insecurity and needs, changes in the demographic pattern, and urbanisation. Globally, about 690 million people were hungry and 60% depended on agriculture for livelihoods (FAO, 2020; Poudel *et al.*, 2020). Further, by 2050, the global population is projected to reach 9.8 billion, with two-thirds residing in urban areas (Searchinger, 2018; Barthel *et al.*, 2019). Increasing population and urbanisation impose changes to land use patterns, create competition for land by different economic sectors, and shift the size of the population involved in and dependent on agriculture as opportunities in other sectors are pursued. The demand for

housing, growth of industries, and associated services result in reduced availability of land to expand agricultural production.

The growth in population, urbanisation, and associated changes in land use and climate change combine to disrupt food and agriculture systems observable in disproportionate food gaps across regions. Estimates by crop category indicate the need for a significant increase in supplies of cereals by up to 56%, a maximum of 54% for fruits, and an upper limit of 51% for vegetables by 2050 (Sun *et al.*, 2020). At face value, the current levels of global crop production provide indications that there is enough food to meet the needs of the global population. However, an in-depth analysis by region shows gaps in both production and consumption of healthy diets. The global and regional level food consumption by food types shows gaps, with Sub-Saharan Africa falling below the minimum and maximum healthy dietary requirements. The global average dietary energy requirement for a healthy life (ADER) is 2,353 kilocalories/person/day (kcal/p/d) while the global production of crops consumable by humans is 5,935 kcal/p/d (Berners-Lee *et al.*, 2018). However, after discounting of harvest losses, diversion to livestock production, and post-harvest losses, the produced average decreases to 2,531 kcal/p/d globally. According to Berners-Lee *et al.* (2018), the minimum of fruit and vegetables required for a healthy diet is 255 kcal/p/d against global access of 159 kcal/p/d and Sub-Saharan Africa with 193 kcal/p/d. The maximum healthy diet needs for sugar and sweeteners is 150 kcal/p/d against global access of 189 kcal/p/d and Sub-Saharan Africa at 153 kcal/p/d. Further analysis by Berners-Lee *et al.* (2018) reveals that Sub-Saharan Africa's average consumption of vegetable oils is 173 kcal/p/d, which is below the expected maximum of 360 kcal/p/d and the global average of 219 kcal/p/d. The consumption of animal products has increased, and projections are that by 2050, there is a need to increase the production of dairy (65%) and meat (76%) products (D'Odorico *et al.*, 2018). A study with a sample of 974 primary school children in 5 districts in Mashonaland West Province of Zimbabwe revealed a disparity of high incidences of obesity among urban school children than those in rural areas, and one of the factors associated with the difference being the consumption of processed foods (Kambondo & Sartorius, 2018). The global and localised gaps and shifts in diets pressure the need to increase the capacity for crop production to meet the needs of both humans and animals.

The highlighted food gaps demonstrate the global and local challenges already on hand for food and agriculture systems, given the current crop production practices and trends. These are at risk of worsening in the context of climate variability and change. The dilemma in responding to the challenge is that while some African and South Asian countries doubled their population size, they experienced low crop yields, high food and nutrition insecurity and lack of food self-

sufficiency, and more intense effects of climate variability and change (Georgise *et al.*, 2019; Shabnam *et al.*, 2019).

2.3. Climate change effects on crop production

The challenges of increasing demand for food and crop productivity are occurring at a time when the effects of climate variability and change are already being experienced globally. The consequences of climate variability and change on agriculture livelihoods and economic systems are instigated by the response and performance of crops, animals and ecosystems (Gitz *et al.*, 2016). The multiple and context-unique effects of climate variability and change include incidences of warmer temperatures, change and unpredictability in duration and characteristics of rainy and agricultural seasons, cyclones and floods, and frequency of droughts, rising sea levels, melting glaciers, and occurrence of weather extremes (Pathak *et al.*, 2018; Shabnam *et al.*, 2019). The underlying causes of climate variability and change include natural factors and human actions in the industrial and agricultural sectors. The human practices, technologies, and inputs used in crop production that contribute to climate change include deforestation, burning of crop residue, inability to manage organic materials, incorrect agricultural practices, and application of some nitrogen-based fertilizers. Though climate variability and change will have effects at the global level, the intensity is projected to be more devastating in regions where communities are largely dependent on agriculture and with limited diversity of economic activities (Dube *et al.*, 2016). Many of these communities are in developing countries including those in Sub-Saharan Africa. A combination of changes in temperature, rainfall and ecosystem composition put the subcontinent at risk, as most smallholder farmers in sub-Saharan Africa are dependent on rains for both their crop and livestock production and incomes. The countries where climate change will have more intense effects have weak policies, a prevalence of destructive farming practices that cause overuse and degradation of land, and dysfunctional market systems. In addition, Dube *et al.* (2016) quoting the Intergovernmental Panel on Climate Change (2007) note that Sub-Saharan Africa is most vulnerable to the effects of climate change for several reasons that include its geographical location within a drought-prone and warmer zone, limited and weakened capacities in terms of access to resources and information.

The changes that smallholder farmers experience from the effects of climate variability and change include a reduction in crop and animal production, conflict over resources such as water access and availability, and incidences of crop pests and animal diseases. A global modelling study by Ray *et al.* (2019) that covered the period between 1973 and 2013 showed the existence of a statistically significant relationship of 54% to 88% between weather and crop yields, based on an analysis of ten of the major global crops that included barley, cassava, maize, oil palm, rapeseed, rice, sorghum, soybean, sugarcane and wheat. In this analysis, weather-related

changes are attributed to a decrease in cereal yields by between -0.9% and -0.3% for rice and wheat, and there was a 0% increase for maize (Ray *et al.*, 2019). Indications are that some regions would fall behind the required minimum threshold for increasing agricultural productivity. It was estimated that by 2030, Africa would experience 24% growth in agricultural productivity, which would be below the required increase of between 70% to 100% after adjusting to the effects of climate change (Whitfield *et al.*, 2018; Kaptmyer *et al.*, 2019; Mason-D'Croz *et al.*, 2019). In Sub-Saharan Africa, the climate-related negative changes were more significant for maize (-5.8%), rice (-3.1%), wheat (-2.3%), and sugarcane (-3.9%). The only marginal increase (0.7%) for the region was for sorghum. A study of eleven crops in Rwanda found that the future productivity for all the crops would be negatively affected by climate change in the absence of adaptation by farmers. For example, the decline in yields was projected to be at least 10% to 15% for bush bean, Irish potato, and maize in two different modelled regimes of climate change where the key independent variables were temperature and precipitation (Austin *et al.*, 2020).

The crops providing the largest share of food calories in Southern Africa are maize, sorghum, cassava, and sugarcane. In South Africa, these major crops recorded decreases of up to 12% across the board in consumable food calorie production and in Zimbabwe, this was at 10% (Ray *et al.*, 2018). In Zimbabwe, a study of three smallholder irrigation schemes in three districts of Midlands Province with a sample of 317 farmers found communities experiencing increased occurrence of droughts and water stress incidences (Mwadzingeni *et al.*, 2021). According to Manyeruke *et al.* (2013) and Ndlovu *et al.* (2020) key climate change impacts on Zimbabwe include increasing rainfall variability, frequency of droughts and floods and high average day temperatures and these are attributed to a reduction in maize production and the 2011/12 importation of 50 % of domestic requirements. Manyeruke *et al.* (2013) observe changes to Zimbabwe's agro-ecological regions. Notable is the reduction in the size of the food producing Regions II (49%) III and V (14 %) which could be associated with a reduction in agriculture production. On the other hand, Regions IV (5.6 %) and V (22.6 %) that are less favourable for food production are observed to have expanded and become drier increasing the risk of food and nutrition insecurity (Manyeruke *et al.*, 2013). Among the effects resulting from the climate shocks were the loss of livestock because of droughts and households spending more time fetching water. The loss of livestock, a key productive asset for rural smallholder farmers in Zimbabwe, and spending more time fetching water, affect the productive capacity and incomes of households.

The projected decline in productivity consequently implies exposure of farmers to risks such as shortage of food, malnutrition, low incomes, inability to meet livelihood well-being and social needs, and low re-investment in production with vicious cycle effects. Various writers have profiled

how climate change will negatively impact various dimensions of livelihoods including food and nutrition security, crop losses, water security, agriculture income, prices of goods, and reduced employment opportunities (Thakur & Bajagain, 2019). In the absence of measures to prevent or mitigate the risks, farmers would be forced to adopt coping mechanisms that include liquidation of productive and non-productive assets, adjustments to food consumption, withdrawal of children from school, and households being averse to pursuing high-risk and high-return investments. Protecting farmers and food and agricultural systems against climatic risks requires significant innovation, transformation, scale, and sustainability of risk mitigation measures. The nature and scope of risk exposure and coverage and mitigation measures available to farmers would potentially influence their perception and decisions on the adoption of adaptation measures. It is for this reason that attention of research and policy has been drawn to understand and respond to the relationship between scale and sustainability in the adoption of adaptation measures in the context of climate variability and change.

2.4. Adaptation to climate variability and change overview

The policy and programmatic implications of the food system transformation framework is the recognition that addressing the threats to food and agriculture systems entails attention to multiple interconnected points, involvement of multiple interrelated actors and the role of the enabling environment of the system. Foundational to food systems transformation is the performance and role of agriculture systems in the cultivation of crops and trees, and rearing of animals for human, animal and industrial purposes. The disruptions to the performance of food and agriculture systems must be understood beyond solely the acts of cultivation and rearing but how this relates to and impacts the broader food and agriculture systems. Without disregarding the link to the broader systems, a thematic or issue focus, may be necessary. This will enable critical understanding of the issues and strategies for better integration into the systems. The issue focus applies to climate change adaptation, which has received considerable attention for its relevance to address the threats, challenges and opportunities in food and agriculture systems.

The concept of adaptation has been subjected to varying definitions, though most refer to its process nature, the presence or anticipation of a stimuli, the varying levels and scope at which effects and action happen, and its purpose to diminish the effects of and take advantage of opportunities presented by climate variability and change. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as a process where a system and its actors adjust to actual or anticipated scenarios of climate risk and its effects (IPCC, 2014). The presence or anticipation of an effect from a climate scenario instigates adaptation by actors. Further, other scholars have argued that adaptation actions can be reactive and autonomous or anticipatory and planned (Feng *et al.*, 2017; Rahman & Hickey, 2019). The reactive and autonomous adaptations

are localised and an instant reaction to a change or vulnerability and may involve the actions of individual farmers at their farms and those taken by communities (Feng *et al.*, 2017; Rahman & Hickey, 2019). The anticipatory or planned adaptation tends to have a wider scope of effects and involves the actions of both individuals and public actors. The actions are a response to large-scale vulnerabilities and their implementation and support involve public and private sector institutions and are informed by knowledge-based predictions of scenarios (Rahman & Hickey, 2019). The interplay of actions and influences between the different levels of adaptation cannot be ignored and needs to be explored and strengthened for a more effective response.

The extent of the effects of climate variability and change has been subjected to different modelling scenarios. What is certain from the different models is that the intensity of the effects will worsen unless adaptation measures result in significant changes that are transformative, sustainable, and resilient to even extreme scenarios. The significance of sustainable and resilient adaptation to climate variability and change is underscored in global, continental, regional, national, and local level policies, plans and programmes. The international agreement on climate variability and change is framed in the United Nations Framework Convention on Climate Change (UNFCCC) of 1992. The UNFCCC initiated and supported signature initiatives on adaptation that include the National Adaptation Programmes of Action (NAPAs) and National Adaptation Plans (NAPs) as mechanisms for identifying and planning for adaptation needs appropriate for implementation in each country. International commitment to action on climate change adaptation is further reinforced in the 2030 Sustainable Development Agenda's 17 SDGs (Hammill & Price-Kelly, 2017). The Intergovernmental Panel on Climate Change (IPCC) was set up as a mechanism for providing evidence on climate change effects to inform global policies. The 2015 Paris Agreement is a global commitment to reduce, adapt, and increase the support for developing countries in responding to the effects of climate change. Parties to the 2015 Paris Agreement set global goals to combat climate change that are reviewed and adapted on a 5-year cycle. Commitments set in Article 2 of the Paris Agreement include, basing on pre-industrial levels, reducing greenhouse gas emissions culminating in containing the average increase in temperature to below 2°C, and with efforts to limit this to 1.5°C, and increasing ability for adaptation and resilience to climate change (United Nations, 2015). Parties to the Paris Agreement were required to set nationally determined contributions towards the global goals. To this end Zimbabwe first submitted its intended nationally determined contributions in 2015 followed by a revised submission in 2021. The energy sector predominated attention with focus on reducing its share contribution to greenhouse gas emissions. Also included were adaptation actions in crop and livestock production, resilience in management of climate induced disasters, and better management of water resources and irrigation (Government of Zimbabwe, 2015). In the 2021 submission the Government of Zimbabwe expanded coverage of the sectors,

greenhouse gases, revised emissions target, and adoption of additional climate policies (Government of Zimbabwe, 2021).

The African Heads of State and government in the June 2014 23rd Ordinary Session of the African Union (AU) in Malabo, Equatorial Guinea, endorsed climate-smart agriculture to be included in the continent's flagship New Partnership for Africa's Development Programme. The African Ministerial Conference on the Environment (AMCEN) of 2017 affirmed the commitment of member states to support action on climate change. The African Union Climate Change and Resilience Development Strategy and Action Plan (2022-2032) is informed by the same concerns over the impact of climate change reflected at national and regional levels. The prioritized strategies seek to support the strengthening of implementation of regional and national priorities by focusing on governance and policy, transformation of systems and ecosystems, enabling means and capacity for implementation, and complementing opportunities from regional initiatives (AU Climate Change and Resilience Strategy and Action Plan, 2022-2030). The spirit of the Strategy and Action Plan aligns with the African Union 2021-2027 Green Recovery Action Plan that prioritizes climate financial resource mobilization, renewable energy, nature-based solutions and biodiversity, resilient agriculture, and green and resilient cities (AU Climate Change and Resilience Strategy and Action Plan, 2022-2030). The African Union's Agenda263 identifies 7 priority focus areas for the continental body that include inclusive growth and sustainable development, continental integration, good governance, democracy, respect for human rights, justice and the rule of law, peace and security, cultural identity, common heritage, values and ethics, people driven development, and global player and partner (AU Climate Change and Resilience Strategy and Action Plan, 2022-2030). Notable in the Agenda263 is the acknowledgement of the impact of climate and the continent's commitment for efforts towards global mitigation and adaptation actions. Further acknowledging the potential impact of climate change to the continent's aspirations Agenda263 specifically sets out climate change and environment priorities that require to be acted upon with a sense urgency. These include regional technology centres, climate change programmes targeting women and youth, resilient agricultural development programme, sustainable forest management programmes, national adaptation institutional mechanisms and sustainable exploitation and management of the continent's diversity (AU Climate Change and Resilience Strategy and Action Plan, 2022-2030).

At the regional level, the 2015 Southern African Development Community (SADC) Climate Change Strategy & Action Plan (CCSAP) notes the vulnerability of member states to the effects of climate change, with some countries already experiencing extreme weather events such as flooding and droughts (SADC, 2015). Climate change is also considered for its impacts on efforts to address pre-existing challenges that include poverty, food insecurity and development goals

(SADC 2015). According to SADC (2015) out of 14 challenges associated with climate variability and climate change 6 of these affect all 14 SADC member states. The challenges shared across members states relate to increasing occurrence of droughts, decreasing and shifting rainfall pattern, changes in river flows and occurrence of wildfires and localised flooding. The economic growth of the region is projected to depend on developments in the agriculture and mining sectors both of which have an association with actions that could intensify or mitigate the effects of climate change. The region further affirms the impact of climate change on agriculture productivity and food security of member states (SADC, 2015). The SADC Climate Change Strategy and Action Plan aims to promote harmonized and coordinated adaptation and mitigation actions within and between member states and at regional level. The overall goal of the strategy is to implement adaptation and mitigation actions that will improve livelihoods, attain sustainable economic growth and fairly contribute to the global good (SADC, 2015). The three strategic objectives of regional strategy are focused on implementation of adaptation measures, reduction of greenhouse gas emissions and mobilizing resources, technology and building capacity for implementing programmes. The strategies prioritized by the region are in the agriculture, water, biodiversity, fisheries, human health, human security, settlements and infrastructure, tourism, mining and other extractives industries. Further the region identified specific sector strategies and actions that will contribute to reduction in greenhouse gas emissions in energy, agriculture, land use, forestry, industrial processes, waste, transport, human and settlements and infrastructure (SADC, 2015). To support implementation of the strategy the regional block envisages institutional mechanisms for coordination, technical support and national and regional centres of excellence on climate change (SADC, 2015). The 2015 Strategy and Action Plan adds impetus to other plans and efforts to climate change response that include the 2015 Revised Regional Indicative Strategic Development Plan (RISDP), 2010 Climate Change Framework and 2013 Protocol on Environmental Management for Sustainable Development, 2015 Regional Green Economy Strategy for Sustainable Development and Action Plan, the Infrastructure Development Master Plan; the SADC Industrialization Policy, 2014 Regional Agriculture Policy and 2020 SADC Science, Technology and Innovation Climate Change Response Framework. All efforts share a deliberate intent to align and compliment continental and global strategies.

The Zimbabwe government policy framework contributes to and contextualises the regional, continental, and international initiatives on climate variability and change. In the period between 2012 and 2019, the Zimbabwean Government developed various policy and strategy frameworks and tools that incorporate measures to respond to the effects of climate variability and change. The Government of Zimbabwe's 2016 Climate Policy was formulated in the background of acknowledgement of the effects of climate change marked by variability of both weather and climate events and their effects on the economic sectors (Government of Zimbabwe, 2016). The

policy considers, among others, poverty and water insecurity as consequential effects of rainfall variability driven by climate change. Notable observation in policy is the predominant consideration of climate risks and exclusion of the other forms of risks. Consideration could have been made that poverty and water insecurity pre-existed climate variability and change and the possibility of both being sources of risk to communities. In the Zimbabwe 2024 Rural Livelihoods Assessment households experienced multiple shocks with results showing a significant share for sharp increase in prices of cereals (58.7 %), cash shortage (69.5%) and prolonged mid-season dry spells (88.7%) (Food and Nutrition Council, 2024). There are multiple other shocks that include chronic illness, livestock diseases, high costs of mobile money or swipe, sharp drop in livestock prices and crop pests 14 to 19.6 % (Food and Nutrition Council, 2024). The narrow focus on climate change in the Climate Policy is extended to its emphasis on the need to integrate climate change in other sectors (Government of Zimbabwe, 2016). This places climate change on a superseding position over other risks and sectors. The reality affirmed in the 2024 Rural Livelihoods Assessment is that smallholder farmers are concurrently faced with multiple risks. In the Zimbabwe Country Food and Agriculture Delivery Compact, the African Union (2023) also acknowledges that besides climatic shocks Zimbabwe experiences other shocks that include economic, crop and livestock diseases, health and deaths. In a context of multiple shocks, equally possible might be the need consider integrating other sectors and risk drivers into climate change strategies. The multiplicity of risk factors merits that all are accorded due consideration for the weight of their impact and prioritization by smallholder farmers to influence more relevant holistic and integrated climate change policies and strategies.

The Government of Zimbabwe's Climate Policy highlights the importance of collaboration between national and international institutions (Government of Zimbabwe, 2016). This is imperative for leveraging on capacities, given the multifaceted, complex and synergistic effects between climate change and other risks and sectors. Despite attention on collaboration the policy does not present a more apparent breadth to include the private sector. This might be a miss given the potential contribution of the sector to innovation and sustainable access to quality agriculture inputs, extension and weather information services, financial services and mitigation of risk through weather index crop and livestock insurance. The limited inclusion of the private sector is pointed out by the Food and Agriculture Organization 2021 global update report (Crumpler *et al.*, 2021). Zimbabwe has a high penetration rate of mobile phones (97.7 %) and internet (73.3 %), and this can be attributed to the private sector (Postal and Telecommunications Regulatory Authority of Zimbabwe, 2023). In 2020 Zimbabwe had an energy access of 53 % with rural areas at 37 %, though still experiencing daily power blackouts of between 12 to 14 hours (World Bank, 2023). Despite the high mobile network penetration access to energy will be a barrier to effective use as users may not charge devices and have interrupted network services. This will

affect effectiveness in sharing and seeking climate and agriculture related information particularly in rural areas.

Zimbabwe's Climate Policy sets the foundation for fashioning and implementing other strategies and plans such as the Zimbabwe Agenda for Sustainable Socioeconomic Transformation, National climate-smart agriculture framework (2018-2028), Zimbabwe's National Climate Change Response Strategy, National Agricultural Policy Framework 2019-2030, the Comprehensive Agricultural Policy Framework, and the Transitional Stabilization Programme. The policies and strategies focus on addressing investment, awareness and capacity building, sustenance, competitiveness, and improvements in infrastructure, production and post-harvest management, access to input and output markets, incomes, and employment in the agricultural sector to build resilience and address the country's food and nutrition security in the context of climate variability and change (Government of Zimbabwe, 2012a; 2013b; 2018c). The specific tools to guide practical implementation of responses to climate variability and change such as the climate-smart agriculture manual for Zimbabwe and Zimbabwe Climate-Smart Agriculture Investment Plan have been developed (Ngara, 2017; World Bank, 2019).

The increased vulnerability of food and agricultural systems to multiple factors is evident and demands the promotion of sustainable agriculture practices that increase food production, food and nutrition security, and those that guarantee access to income for continuity of investment in production and food access. Across all levels, there is shared consensus on the need for efforts and measures to improve access to services that support farmers and the agricultural sector to adapt to climate variability and change.

2.5. An overview of climate-smart agriculture practices and their performance

It is important to promote measures that support farmers to play their part in reversing, preventing, and mitigating the effects of climate variability, and change, restore, sustain, and increase agricultural productivity. This contributes to balancing the challenges imposed by climate variability and change, the growing food needs and food and nutrition insecurity, and responsible management of natural resources and development. One response is climate-smart agriculture (CSA) practices that include technologies, approaches and services implemented in the agriculture sector. The promotion and adoption of CSA practices gained traction around 2009, with interest and drive from international agencies including the FAO and the World Bank. The CSA practices are an appropriate policy and programmatic response to the actual and predicted varied effects of climate variability and change on food and agricultural systems and development. A technology or approach is considered climate-smart when its outcomes contribute towards preventing or mitigating the effects of climate variability and change. As argued by both Campbell

(2017) and Georgise *et al.* (2019), sustainable change must accompany the promotion and use of CSA practices and approaches. The CSA practices contribute to three key interrelated pillars 1) increased agricultural production and incomes, 2) promoting and enhancing resilience of agricultural systems and 3) reducing the emission of greenhouse gases. These are commonly referred to as the triple wins of CSA (Williams *et al.*, 2015).

The agricultural practices that are climate-smart are diverse, including enabling legal, regulatory, and institutional mechanisms, public and private sector financial resources, and technologies implemented variously at farm, community, national, regional and global levels. The practices are implemented within a systems framework which is strategic, as the complexity of climate effects demands the response of more than one sector and player. This implies the necessity of concurrent and complimentary implementation of interventions, with the participation and efforts of diverse public, private, civil society sector and farmer stakeholders at all levels. This is relevant for this study, given that understanding the diverse risks of smallholder farmers would open pathways for multiple actors to be involved in the delivery of services as part of CSA policies and programmes.

In various parts of the world, CSA practices have been promoted, with many in developing countries. It is worth noting that some of the technologies and approaches promoted as CSA practices are not necessarily new but have been advocated for and implemented in the past though without reference to climate variability and change, as argued by Taylor (2017) and Whitfield *et al.* (2018). This has allowed some of the approaches to be improved upon. The results from CSA programmes demonstrate impressive positive farm-level outcomes such as increasing productivity and incomes, improving the efficient use of water, reducing soil erosion, increasing retention of soil moisture, reducing the use of chemical fertilizers, and restoration of soil nutrients.

Balafoutis *et al.* (2017) and Schimmelpfennig (2016) provide a comprehensive analysis of the global performance of different CSA practices. The analysis of the performance of variable nutrient application technologies and precision irrigation methods provide indications of their combined positive impact on reducing water usage with subsequent lowering of pumping requirements that further cut the emission of greenhouse gasses, while the efficient water application contributes to the reduction in the emission of nitrous oxide (N₂O). Nitrous oxide is generated from a combination of manure and synthetic fertiliser, with a reduction in the use of the latter lowering emissions. According to Balafoutis *et al.* (2017), analysis results at two farms, one 156 hectares, and the other 53 hectares in New Zealand that used variable irrigation methods demonstrated respective 21.8 % and 26.3 % savings in the use of water. In the United States of America, the State Water Efficiency and Enhancement Programme (SWEEP) had by 2018

mobilized funding worth \$ 97,5 million from multiple stakeholders that was used to support improved irrigation management, use of drip irrigation, water storage and recycling, and soil moisture monitoring with coverage over 100,000 hectares of land (Lewis & Rudnick, 2019). According to Lewis and Rudnick (2019), estimates are that SWEEP contributed to significant savings in the annual greenhouse gas emissions that were equivalent to the reduction of 15,000 cars from the road. In addition, the improved water management practices implemented in crop production annually saved more than 28 billion gallons of water (Lewis & Rudnick, 2019). A study in the USA that used national data on a sample of 384 farms found the use of precision agricultural technology and services being motivated by the need for cost savings, yield improvement, and convenience (Thompson *et al.*, 2019). A significantly high (88%) number of the farmers in the study sample indicated that precision agricultural technology was a contributor to the profitability that their farming enterprises were experiencing.

In Nepal, an in-depth study that covered two out of twenty-one districts found women farmers practicing zero and minimum tillage increasing production efficiency and productivity for rice, wheat, and maize with reduced burden of labour on women (Khatri-Chhetri *et al.*, 2020). In Mongolia 1,835 farmers in four out of twenty-one provinces enrolled for index-based livestock insurance in 2009. Severe winter, a common phenomenon in the country led to the loss of livestock in the 2009/2010 season and compensation payments to 95.4% of insured farmers in one province. A study by Bertram-Huemmer & Kraehnert (2018) found insured Nepali farmers having greater numbers of livestock than uninsured farmers annually from 2011 to 2013. The recovery of farmers was differentiated by the insurance premiums and compensation payments received. Farmers with higher premiums and compensation amounts demonstrated higher recovery of their herd, than those with lower payments and compensation. Ownership of insurance and premium values were attributed to the differences observed in the recovery of herds by Nepali farmers. In Mexico, a sample of 5,879 rural households that participated in a programme promoting insurance demonstrated that an increase in the size of land allocated to crop production was associated with ownership of insurance and the 30 % and 40 % increase in household income and expenditure, respectively attributed to insurance pay-outs (de Janvry *et al.*, 2016).

The vulnerability of Africa to temperature, rainfall, and ecosystem changes has seen most CSA practices being variously promoted in different regions of the continent (Connolly-Boutin & Smit, 2016; Dube *et al.*, 2016). In Africa, CSA practices have been promoted at varying scales and with some evidence generated on their performance. Small irrigation systems have been used to mitigate the impact of rainfall variability and moisture stress conditions. The Research Program on Dryland Systems and Africa RISING projects were implemented in the Chinyanja Triangle an

area that spreads across three countries: Zambia, Mozambique and Malawi (Mango *et al.*, 2018). A study by Mango *et al.* (2018) on sample of 312 households from four regions representing the three countries attributed a significant positive increase in agriculture incomes to the use of small-scale irrigation by the farmers. In Malawi, the Protecting Ecosystems and Restoring Forests in Malawi (PERFORM) project promoted various technologies and approaches in six communities in Machinga District (Nyagumbo *et al.*, 2019). Farmers in a study sample drawn from five of the communities associated the introduction of improved input varieties, farm, and off-farm diversification, and irrigation technology with restoring forest ecosystems and strengthening the resilience of the agriculture system. There was an observed 51 % increase in yields for farmers who adopted conservation agriculture (Nyagumbo *et al.*, 2019). A comparison of farmers who adopted CSA practices and those using conventional methods showed differences in yields from rain-fed-produced maize. Farmers practicing CSA in high rainfall areas had mean yields of 3,965 kg/ha, while those in low rainfall areas had 3,595 kgs. The farmers practicing conventional methods had maize yields of 3,049 and 2,675 kg/ha in the respective areas.

In Sudan and Mali, to overcome nitrogen deficiencies, the efficient application of inputs through micro-dosing fertilizer was attributed to an increase in yields from 122 to 575 kg/ha for sorghum and pearl millet (Aune *et al.*, 2017). Evidence from adoption of improved fallows in select countries showed a positive impact on the triple wins of CSA. Improved fallows innovate on conventional natural regeneration of soils by adding planting of fast-growing crops or legume plants after harvest with the expected impact on regenerating soil fertility. In Zambia, over three years maize yields increased to 5 and 6 tonnes per hectare in two and three-year fallow periods, while yields from conventional fields with fertilizer application had 4.9 and 4.3 tonnes and those without fertiliser had 1.2 and 1.9 tonnes (Partey *et al.*, 2017). Party *et al.* (2017) also refer to a case in Western Kenya, where the adoption of improved fallows resulted in a 200 % increase in maize yields. In two communities under two districts in the Upper West Region of Ghana, to restore soil fertility over two seasons no-tillage practice in soybean and maize production resulted in significant increases in yields, reduction of labour cost, and increased income, as compared to the same crops applied with tillage and fertilizer (Buah *et al.*, 2017). In one of the districts, the soybean yields on conventional tillage were 393 kg/ha and 780 kg/ha in 2013 and 2014 respectively. On the other hand, over the same period, the soybean yields on no-tillage were 453 kg/ha and 1,180 kg/ha respectively. The no-tillage soybean crop recorded a 60 kg/ha and 400 kg/ha higher yield than the tillage crop in 2013 and 2014 respectively. A study on a sample of farmers located within a 10-kilometre radius in one rural commune of Mali planting improved and local varieties of millet and sorghum on contour ridges showed positive high yields from the former, as compared to the latter, with variations of between 25% to 55% (Traore *et al.*, 2017). In Ghana's Western and Ashanti regions, cocoa farmers in two districts were introduced to improved

inputs, mulching, agroforestry, and intensification, while others used conventional methods. A study of 80 households selected from the two districts had results showing average yields of 363 kg/ha on conventional methods and 501 kg/ha on CSA practices with concurrent increase in crop income (Akrofi-Atitianti *et al.*, 2018). CSA practices had additional positive impacts that included improved access to food, reduced deforestation, and lowering of greenhouse gas emissions. In South Africa's Limpopo Province in the Mopani, Capricorn, and Waterberg Districts farmers adopted mulching, adapted irrigation methods, input, and soil management to mitigate the effects of low moisture conditions and poor soil quality (Musvoto, 2019). A study of 30 smallholder vegetable producers found a 5 to 50 % reduction in water use, a 20 to 200 % increase in yields, 13 to 192 % increase in gross income, and 17 to 64 % reduction in electricity costs (Musvoto, 2019).

In Northern Kenya, a 2011 drought led to farmers in one district experiencing loss of livestock of between 20 % and 50 % and farmers receiving payouts from index-based livestock insurance. The insurance pay-outs were associated with reduced chances of households adjusting meals (25 %) and selling livestock (35 %) as strategies to cope with drought (Michael *et al.*, 2018). In Zimbabwe, crop insurance products have been offered including a ZimNat Lion Insurance Company weather-based insurance, Nyaradzo Group Agriculture Insurance and EcoFarmer seed and yield protection insurance (Arce, 2016; Moyo, 2019). Studies in Zimbabwe on adoption of insurance indicate variable (low to high) awareness and very low levels of usage of the products dependant on the crop (Nyathi & Tshuma, 2024; Runganga & Mumbengegwi, 2020). The reasons for low adoption include high costs of premiums, low incomes, inappropriateness of products to needs of farmers, mistrust of service, access difficulties, and access to traditional self-insurance (Nyathi & Tshuma, 2024; Masara & Dube, 2017; Runganga & Mumbengegwi, 2020).

The examples demonstrate the positive impact of CSA practices. Given the impact, it would be highly expected to have minimal challenges in convincing smallholder farmers to adopt and sustainably implement the practices. The impact on productivity and income is consistent with the aspirations and motivations of most farmers, let alone the larger-scale transformation needed in food and agricultural systems. However, evidence points to challenges with the scale and continuity of the adopted practices.

2.6. The dilemma of scale and sustainable adoption of CSA practices

Though various CSA practices demonstrate positive impact the recurrent challenge is the low uptake and scale of adaptation measures, drop-out of adopters and lack of sustainability after adoption. A study on a sample of 30 households from one village in Colombia found that the adoption rates were only 37 %, 23 %, and 23 % despite 100 % awareness of irrigation

technologies, homestead gardens, and cook stoves respectively (Peterson, 2014). A study was conducted that included 114 household interviews, 11 key informant interviews, and 4 focus groups in one village (commune) in a province of Vietnam. The findings reveal how farmers in Vietnam had low uptake of CSA practices such as improved livestock health and diversification and improved irrigation systems (Phuong *et al.*, 2018). A study in Guatemala that involved 42 agricultural sector stakeholders representing producer associations, research and academic institutions, and donors found that farmers experienced profitability after adopting CSA practices that include crop, water, soil, and pest management (Sain *et al.*, 2017). However, questions can be raised on sustainability in the absence of incentives that, according to Sain *et al.* (2017) were provided, and in the event of a decrease in harvests. The high establishment costs of adaptation technologies such as water reservoirs and drip irrigation can be potential disincentives for scaling-up adoption.

Hailu *et al.* (2014) refer to the low adoption of various improved input varieties in Malawi, Mali, Ethiopia, and Madagascar because of perceptions and limited awareness, and access to extension and financial services, and markets. Conservation agriculture has three principles that are providing continuous cover to the soil using crop residue, practising minimum soil disturbance, and diversification by adopting practices such as crop rotation (Strauss *et al.*, 2021). Strauss *et al.* (2021) conducted a study with 441 farmers across South Africa and the findings indicate that though the adoption of select principles of conservation agriculture was relatively high, the concurrent adoption of all three was low, estimated at less than 14.2 % and rising to 25% in 2020 (Findlater *et al.*, 2019; Strauss *et al.*, 2021). In Zimbabwe, Zambia and Kenya, the adoption rate of conservation agriculture remained very low, with less than 1 % of cropland in these countries being allocated to the practice (Lan *et al.*, 2018).

The low uptake of WII by farmers has been observed in various contexts globally (Sibiko *et al.*, 2018; Yuzva *et al.*, 2018; Teame & Hagos, 2019). Depending on the context, some of the reasons given for low uptake include the high transaction costs, variation between actual losses and losses as determined by the index (basis risk), and turnaround time in the processing of payments. Globally, 62 % of agricultural insurance premiums are estimated to be shared between the United States and Canada and only 1% for Africa (Elum *et al.*, 2018). In low- and middle-income countries, the uptake of agricultural insurance is below 0.3 % of the farmers, according to Budhathoki *et al.* (2019) quoting Mahul and Stutley (2010). In Kenya, below 10% of farmers in the Embu-East sub-county are estimated to have taken up WII products promoted in the area (Sibiko *et al.*, 2018). A study by Sibiko *et al.* (2018) in Embu-East sub-county with 152 farmers that took up insurance experienced growth from 14 to 88 farmers between 2009 and 2012, this was followed by stagnation of around 88 and 86 between 2012 and 2013 and a fall to 60 by 2014. A

similar trend is observed in the same country in the Embu and Laikipia counties among maize farmers, that adopted WII. In a study of 240 farmers that accessed WII, an initial rise in uptake from 2.4 % in 2009 to 36 % in 2012 was followed by a fall in 2014 to 2.6% (Njue *et al.*, 2018). In Zimbabwe, the EcoFarmer insurance product had an initial enrolment of 1,100 farmers in the 2013/14 season and experienced a 60 % dropout of clients by the 2014/15 season (Arce, 2016). It is in the background of these adoption trends that discourse at policy, programme and research has focused on understanding the drivers of adoption decision choices of farmers.

2.7. Smallholder crop farmer risk perception and adoption decision-making

The glaring disconnect between the impact of CSA practices and the low adoption trends has drawn the interest of research to understand the drivers of adopting adaptation behaviours by farmers. The drivers can be viewed as operating first at the point that risk is perceived and second, when the adaptation technology is made available for adoption by farmers. Risk perception has been widely covered for the latter, for its influence as farmers decide to adopt CSA practices (Elrick-barr *et al.*, 2015; Dung, 2020; Ahmed *et al.*, 2021). The diverse perspectives have identified the role of environmental, market, production, technology, financial, human, and institutional factors in generating a perception of risk among farmers. Environmental risks include the occurrence and effects of natural and climate events such as droughts, earthquakes, weather extremes, and alterations to rainfall patterns that disrupt agriculture-based livelihood systems. Market risk includes the state of prices that farmers may and pay for agricultural inputs, what they may and are paid for their crop or livestock outputs, and the functionality of and access to markets. Production risks include the actual and anticipated state and trends in disease outbreaks, weather, and type and access to technology used in production. Financial risks include the ability to generate income, accumulate financial assets through savings, and access external sources of diversified financial services to meet consumption and production needs. Human risks include the actual and probable availability of agricultural labour, the skill sets, wages, and well-being to be productive. The institutional risks include the actual and anticipated state of extension services, infrastructure, agriculture policy, and the legal and regulatory environment for the agricultural sector. It is worth pointing out that the bulk of these sources of risk, except the labour risks, are external to the farmers (Meraner & Finger, 2018; Duong *et al.*, 2019). In the context of climate variability and change, the more dominant view has been on the role of climate-induced effects as drivers of risk to farmers and food and agriculture systems. The anticipation of climate risk induces farmers to develop perceptions of how they are likely to be affected, taking into consideration a variety of factors that include their experience, resources, social networks, and external support. A review of 62 peer-reviewed publications on climate change, the shocks that are identified include an increase in temperature, variability of rainfall, drought and weather extremes (Zhou *et al.*, 2022). In a study of ninety-eight (98) households in Bangladesh, thirteen

(13) primarily climate change effects are identified as drivers of climate change risk perception (Ahmed *et al.*, 2021). The effects include drought, river erosion, floods, outbreaks of diseases and pests affecting animals and crops, heavy fog, extreme summer and winter temperatures, soil infertility, extreme rainfall, depletion of groundwater, scarcity of safe drinking water, arsenic contamination and fires (Ahmed *et al.*, 2021). Similar observations on climate-induced risks are noted by Reddy *et al.* (2022) in India, where a sample of 200 farmers revealed that an increase in temperature, decrease in rainfall, delayed start of the monsoon, and extended summer, were associated with disruptions to agriculture-based livelihood systems that include changes in the number of crops grown per season, and usage of agro-chemical inputs.

At the point that adaptation technology is introduced to farmers, the drivers of adoption are generally classified into three broad but interrelated categories; household or farm, system, and technology level (van Hulst & Posthumus, 2014; Arunrat *et al.*, 2017). The household or farm-level drivers are a combination of the farmer and farm characteristics. This includes the farmer's age, race, income level, level of education and knowledge, attitudes, motivations, membership to groups, employment status and ownership of financial assets, perception and anticipation of risk, and prioritisation and balance between short and long-term benefits (Jambo *et al.*, 2019; Zakari *et al.*, 2019; Nnodim & Raji, 2020). The farmer-level characteristics have been limited to their role in influencing the adoption of adaptation measures and less so, as initiators of risk perception. The farm-related drivers of adoption include the size and location of the farm, types of land tenure or rights, types of soils, ownership, and type of farm physical assets and implements and other infrastructure (Paustian & Theuvsen, 2017; Zakari *et al.*, 2019; Bradley *et al.*, 2020). The drivers of adopting at the system level include the capacity of governance such as institutions and policies, availability of incentives and subsidies, availability of extension, information and financial services, and functionality of market systems and social structures and values. The technology drivers include the type, accessibility, costs, ease of use and maintenance, and social acceptance of the adaptation measure. There is substantial attention given to production-related risks that farmers consider in the adoption process (Sibiko *et al.*, 2018; Klapper *et al.*, 2019; Rueben *et al.*, 2019). This includes risks anticipated if the adaptation measure fails, such as a reduction in harvest. A consequential logical explanation is that when productivity fails or declines, this changes a farmer's sales, net income, food reserves, savings and assets, and ability to meet other needs. However, it is not elaborate whether the key concern starts with the risk of losing production, or the pre-existing social and economic circumstances of the farmer could in themselves be priority risk and influence the decision-making processes. When farmers are exposed to adaptation measures, could it likely that they have pre-existing social, economic, and psychological circumstances that could influence their perceptions and decisions. Further, could

it be possible that both climatic and pre-existing non-climatic risks are important and considered by farmers as they decide to adopt adaptation measures.

The study primarily focused on the farmer household characteristics and whether they could be sources of risk with similar effects on risk perception as the external climate-induced shocks. There is limited literature and research on the role of farmer household characteristics as risk drivers. The limited literature does not necessarily dispute but provides an alternate explanation to the widely held view that external risks and shocks drive farmer risk perception. The alternate view is that farmers have household risks that in themselves could be sources of risk perception that influence decisions to adopt CSA practices. A study by Elrick-barr *et al.* (2015) on two Australian communities covered 400 households that experienced a hazard and those that had not, and the findings point to the role of household risks on risk perception. While experience with a hazard was one of the main drivers of risk perception, there was also a high representation of household risks that included illness or injury, inability to pay for household expenses and emergencies, job loss and unemployment, and change to quality of life. These findings by Elrick-barr *et al.* (2015) posit that the social and economic circumstances of households can be sources of risk with an influence on adaptation decision-making. A conclusion from a study in Kenya emphasises how the assurance of the ability of households to feed their families was a source of risk and important to adaptation decision-making, and not necessarily the performance of the adaptation measures (Cavanagh *et al.*, 2017). Similarly, and though less prominently, Fayso (2018) points to the illness of household members as a source of risk and access to healthcare as a consideration in adaptation decision-making by farmers in Ethiopia. These risks can be perceived as imperative for the survival and well-being of farming households. It is not known from these and other sources, whether the decisions made could have been different, if mechanisms that assured farmers access to their survival imperatives were in place. In addition, there is limited evidence on the scope and breadth of the survival imperatives that could instigate risk perception and the decision-making processes by the farmers. One of the recommendations derived from the findings by Elrick-barr *et al.* (2015) is the need to link climate hazards and personal risks of households in response strategies. The observed intricacy between the daily household risks of families, and technology decision-making underlie the pertinence to better understand the household risk context of farmers.

Though the focus of the study is limited to farmer household characteristics at the point when risk perception is originated, at any given point, multiple drivers can concurrently influence the decision choices of farmers. Rose *et al.* (2018) argue that there is a need to consider diverse systemic environmental, social, economic and political elements that shape the cognitive processes of smallholder farmers exposed to adaptive measures.

Though the current study does not deal in detail with this, it does acknowledge that there are operating context elements that influence adoption of CSA practices. Having the right climate change policies and technical approaches is imperative, but not adequate for success. Climate change and adaptation measures are implemented in environments with elements that can be constraints or enablers to adoption. In the food systems transformation framework, the political and economic drivers is a domain that accounts for the role of politics in adaptation. (International Fund for Agricultural Development, 2021). As argued by Dodman & Mitlin (2015) political relations and political outcomes could influence development interventions and outcomes. In some instances, well-meaning responses to disasters are hijacked by partisan politics for political mileage or punishment (Desportes & Moyo-Nyoni, 2022; Desportes & Hilhorst, 2020). Various scholars have researched and written on how politics motivated the design and implementation of agriculture input support programmes by the Government of Zimbabwe (Mutonodzo-Davies & Magunda, 2011; Desportes & Moyo-Nyoni, 2022; Kabonga, 2023.). Some of the programmes were meant to defend or justify political decisions such as the Fast Track Land Reform Programme, weak state capacity and rhetoric surrounding the targeting economic sanctions. In addition, the Government of Zimbabwe has politicized the image of NGOs and programmes they implement by labelling them as mechanisms for regime change and resistance to populist programmes such as the fast-track land reform programme (Desportes & Hilhorst, 2020; Ntini, 2022; Dendere & Taodzera, 2023). The position of Government can significantly influence who participates and the nature of participation in NGO programmes. The fear of being labelled as aligned to alleged proponents of the regime change agenda and resisting redressing land ownership injustices will stand in conflict with supposedly well intended purposes of NGO CSA programmes. The implementation and results of CSA programmes implemented in such contexts may be compromised. At face value well-meaning programmes promoting CSA practices can have their implementation timelines coincide with political processes such as campaigning for elections. They may also openly target population groups or use implementation structures that by default align to political interests. An example of relevance to this study is the implementation of input subsidy programmes, such as the Presidential input and Pfumvudza. While such programmes promote inputs and practices relevant to climate change adaptation their execution could be shrouded in politics and distort the adoption of CSA practices. As study by Runganga & Mumbengegwi (2020) of 150 smallholder farmers in one district in Zimbabwe found that those that received high value subsidized inputs from government had the likelihood of adopting agriculture insurance. Whether government could sustain input subsidies and the mechanisms for doing so will require exploration. Otherwise, sustaining adoption of insurance without the subsidies will be questionable.

2.8. Chapter summary

The global population which is projected to grow considerably by 2050 is dependent on agriculture for livelihoods, yet a significant proportion is living in hunger. The population growth and its vulnerability are happening at a time of increasing urbanisation, and associated competition for land and changes in land use patterns and diets, and disparities in food supply and demand all combining to exert considerable pressure on the agriculture sector to increase its capacity to produce food. The situation is compounded by the projected threats and actual effects of climate variability and change on food and agricultural systems such as extreme temperatures, frequency of droughts and cyclones, unpredictable rainy seasons, and outbreak of crop and livestock diseases. The climate change-induced factors are associated with the fall in crop and livestock production, and loss of assets by smallholder farmers, with consequential effects on food and nutrition security, income, livelihood well-being, and investment behaviours. Projections point to climate change causing shortfalls in the capacity of the agricultural sector to produce enough to meet the food needs of the global population. The situation is even more dire for developing countries in Africa and Asia, that already have food gaps and are not able to meet the required minimum production thresholds, have weak governance and market systems, and limited access to resources and information. Human actions contribute to climate variability and change through deforestation, farming practices, and the types of agricultural inputs used. The promotion of practices that reverse, prevent, and mitigate the contribution of human action to climate variability and change have been core to global, regional, and country-level institutions, agreements, research, and policy frameworks including the 2030 Sustainable Development Goals, IPCC, UNFCCC, NAPAs, NAPs, AMCEN, AU NEPAD, African Union Commission's Agenda 2063, and SADC CCSAP. The Zimbabwe Government crafted stand-alone and integrated policy and programme frameworks that address priority climate variability and change challenges, complementing regional, continental, and global efforts. At all levels CSA practices have been promoted to attain the "triple wins" that include increasing agriculture production and incomes, promoting and enhancing the resilience of food and agriculture systems, and reducing the emission of greenhouse gases. Across the globe, various CSA practices have demonstrated significant efficacy in contributing to the "triple wins" compared to conventional farming methods. Despite this, there is evidence that demonstrates the low scale and lack of sustainability in the adoption of CSA practices after the closure of programmes and the absence of incentives.

Policy, programme, and research have an interest in understanding the drivers of the adaptation behaviour of farmers to find a remedy to adoption trends. The predominant view has been the role of climate variability and change effects as the drivers of risk to farmers and food and agricultural systems. The anticipation of climate shocks trigger farmers to have a perception of

the likelihood and intensity of being affected and their ability to respond with subsequent effects on their decision on adaptive behaviours. Though there is limited coverage, there are compelling alternative views on the role of farmer household characteristics as drivers of risk perception. Smallholder farmers have household survival imperatives, such as food insecurity, illness, inability to pay for household expenses and emergencies, job loss and unemployment, and change in quality of life. When these imperatives are not addressed, they generate risk perception that can influence farmer adaptation decisions, ahead of, or in conjunction with the external factors and elements related to the adaptation measures. The scope and significance of the survival imperatives and their role in instigating risk perception and decision processes is not fully known and is a basis for further and current research. The understanding of these survival imperatives can inform the design and selection of services provided as part of CSA programmes.

CHAPTER 3 RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents a description of the area where the study was conducted and the methodological process that was implemented from community entry, and data collection, organisation, analysis and presentation. The mixed method research approach used is described. The chapter includes a description of the population and sampling procedures, and the ethical considerations applied in the research process. In addition, the limitations of the research are presented.

3.2. Description of the study area

The study was conducted in Zvimba District, one of the sixteen districts in Mashonaland West Province, in the Central Northern part of Zimbabwe. Zvimba District is located between latitude 17° 42' 0.00"S and longitude 30° 12' 0.00"E. As shown in Figure 3-2 **Error! Reference source not found.**, the districts sharing boundaries with Zvimba include Chegutu in the South, Makonde in the West, Guruve in the North, and Mazowe and Harare in the East. The district has 35 administrative wards and 54 villages, and its capital Murombedzi is located 110 kilometres from the country's capital city, Harare. Zvimba District has an estimated 6,849 km² land area, a population of over 348,000 people, and an average household size of 4.0 persons, based on the 2020 national population census (ZIMSTAT, 2022). An estimated 49 % of the population are men and the remainder (51 %) are women. The dominance of women is associated with the economic opportunity driven rural-to-urban labour migration and the customary practice where men sought wage employment in urban areas, while their spouses remained in rural areas where they dominated in providing their labour in agricultural production (Chambati, 2022). The anticipation of return migration to rural homes by men had households retaining and dependant on rural livelihoods (Potts, 2010).

The dominant productive activities for Zvimba District are a mix of smallholder and large-scale crop and livestock production. The major crops grown in the district are maize, cotton and tobacco, which are predominantly rainfed. Cattle are the most dominant livestock, with some households also rearing small livestock such as goats and chickens. The district is situated in natural region 2a which experiences an average annual rainfall of between 750mm to 1,000 mm, according to Maguranyanga *et al.* (2014) quoting Vincent and Thomas (1960). Mashonaland West Province in general, and the selected study district, is classified as low to medium risk in terms of the likely occurrence of flooding (Samu & Akintuğ, 2020). The province is vulnerable to the occurrence of droughts, though at moderate levels. A thirty-year analysis by Frischen *et al.* (2020) indicates that Mashonaland West, Midlands, Mashonaland Central and Manicaland Provinces are ranked second in the group of provinces that recorded the second-highest average incidences of drought

events. The district's vulnerability to droughts provided an appropriate context for the study, as the farmers already experienced climate change-related stressors allowing them to engage with the research processes from an informed point.

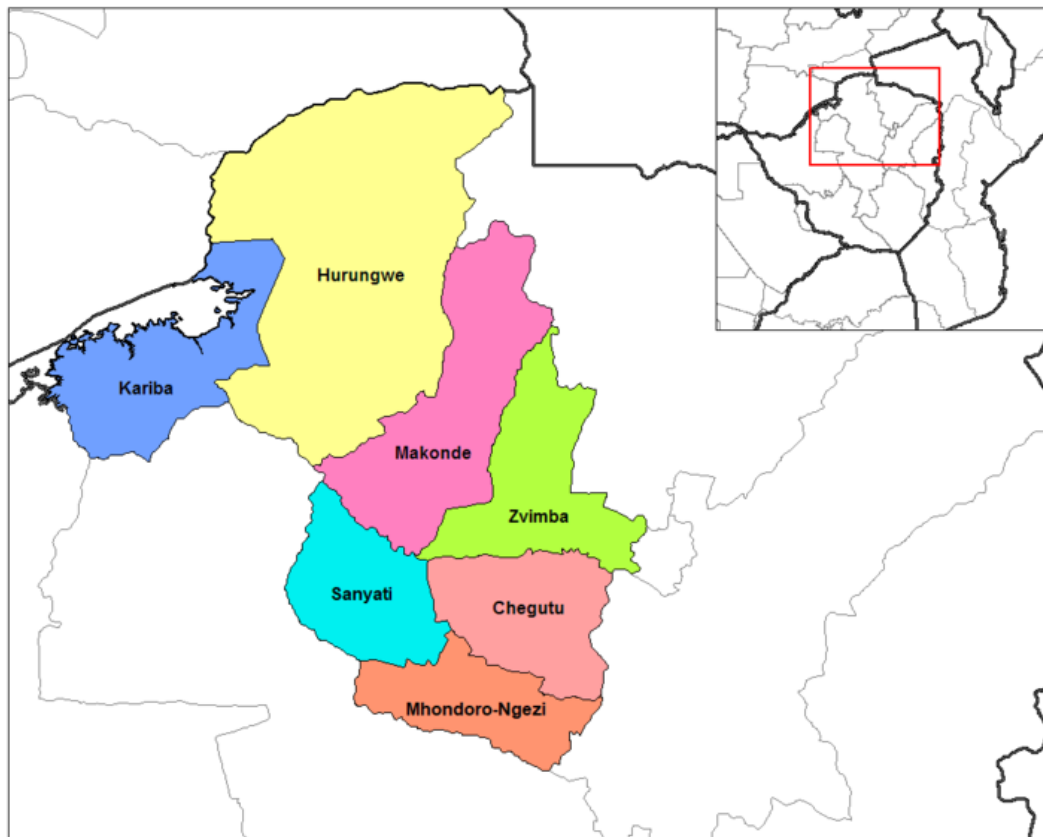


Figure 3-1: Mashonaland West Province Districts

Source: https://en.wikipedia.org/wiki/Zvimba_District

Climate variability and climate change stressors already experienced by communities in Zvimba District include changes in the timing of the rain season, the occurrence of dry spells, an increase in temperature, and incidences of crop pests and diseases (Mashizha, 2019). Farmers in the District associate these climate stressors with a decline in maize crop yields and abandonment of the production of some crop types. These climate change-induced losses of crops by farmers could be potential motivation to pursue solutions to protect and support the recovery and continuity of agriculture livelihoods.

The ZFU CSS programme's nationwide mobilisation activities reached 22,775 farmers, of whom 2,737 were in Zvimba District. Overall, 19,202 (84%) of the mobilised farmers adopted the combo product and in Zvimba District, there were 146 farmers in four wards. In the overall programme outreach, 49% (9,395) of the farmers were women, while the remainder (9,807) were men. The final three wards that are covered by the study are marked in Figure 3-2. Of the 3 study locations, wards 9 and 10 are neighbouring and share similarities of being typically rural settlements and dominated by food-crop and livestock production. In parts of both wards, the farmers produce cotton. The Wards are both located less than 10 kilometres from Murombedzi Growth Point, the focal commercial and administrative centre for Zvimba District. The distance between Murombedzi and Ward 20 is about 67 kilometres. In the large part of Ward 20, in addition to food crops and livestock production, tobacco is also grown as a commercial crop. The Ward comprises a mixture of rural settlements and new resettlement areas that emerged from the Zimbabwe land reform programme.

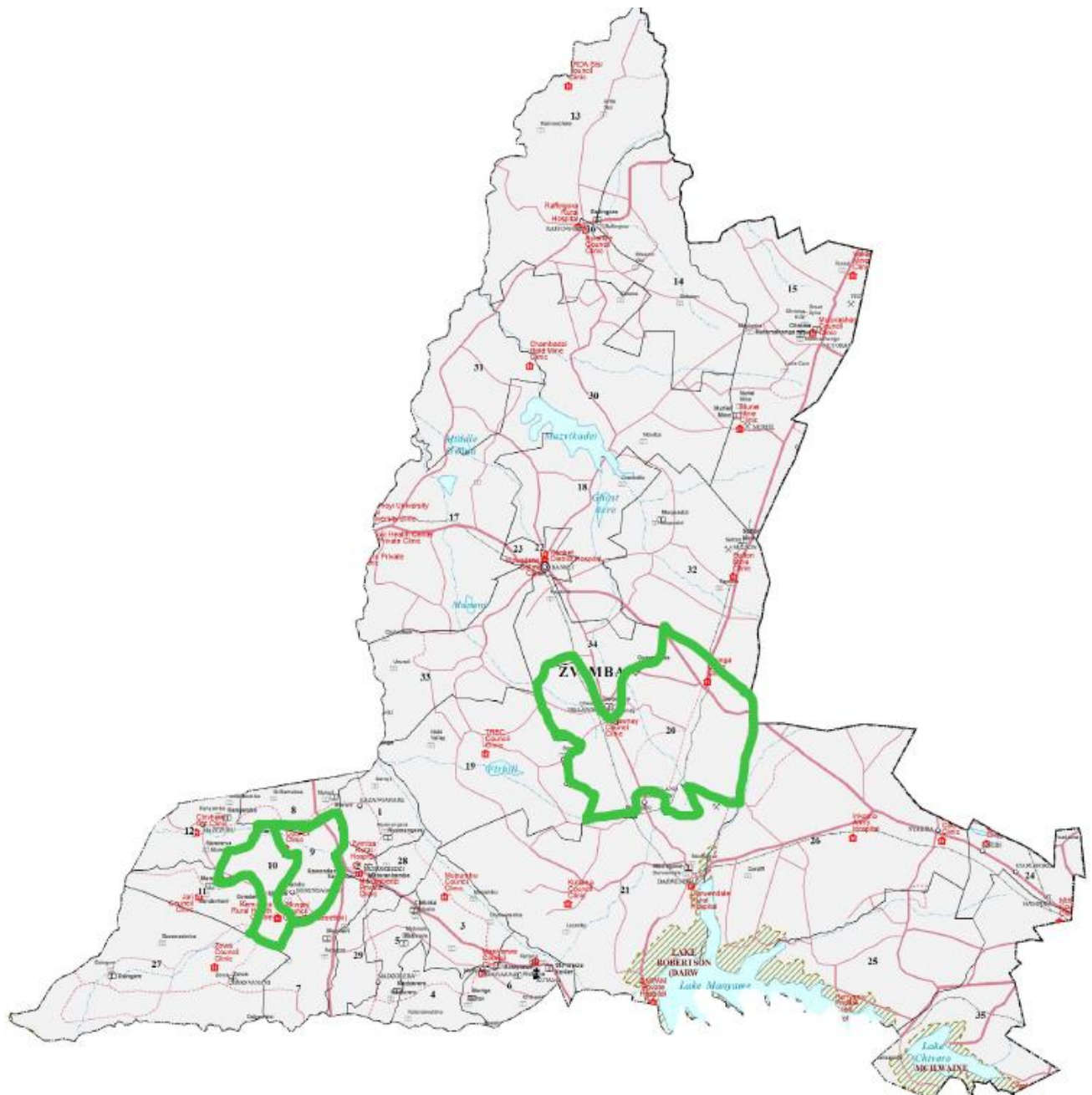


Figure 3-2: Zvimba District wards covered by the study (large border lines)

Source: <https://www.humanitarianresponse.info/en/operations/zimbabwe/infographic/zvimba-district-map>

3.3. Research design

The elements of the research methodology applied in the study are outlined in Table 3-1. The cross-sectional study's research design was informed by the works of Elrick-barr *et al.* (2015), Cavanagh *et al.* (2017) and Fayso (2018) who highlight the limited consideration and yet potentially important role of farmer household risks as risk drivers that could influence the adoption of CSA practices. There are two sub-categories of cross-sectional studies relevant to the current study, 1) the descriptive and 2) the analytical. Descriptive cross-sectional study allow research to describe the multiple characteristics of a population such as their age, gender, income status, and environmental and social context (Zuleika, 2022). The analytical cross-section study allows for the investigation or determination of risk factors and the consequences they may cause (Zangirolami-Raimundo *et al.*, 2018). In the current study's exploratory design, the characteristics of smallholder farmers that are described include their demographic profile, and the climate change and household risks they experienced. After determining the risks, the study explores whether these had influenced smallholder farmer risk perception and the decisions to adopt the combo product. In particular, the research design used was an exploratory sequential mixed method which was considered most appropriate for addressing the research questions on the characteristics and experiences of smallholder farmers with climate change stressors, household risks and the adoption of the combo product. Data was collected and analysed in interrelated phases to allow for an extensive and deeper understanding of the issues (Bazeley, 2018 quoting Johnson *et al.*, 2007). The literature reviewed on the drivers of the adoption of CSA practices raised some issues related to types of risk drivers, the inconsistency of outcomes from the same determinants, and limited attention on the place and scope of household risk factors. These observations were made in a context where the adoption of CSA practices remained suppressed globally, despite evidence that they increased productivity and incomes, reduced greenhouse gas emissions, and built resilience to climate change. The factors driving the adoption patterns have been varied, though dominated by climate change risks (Zhou *et al.*, 2022; Ahmed *et al.*, 2021). The farmer household factors, though acknowledged, have some inconsistent results on their influence on adoption decision-making. In different contexts, factors such as age and education level demonstrate inconsistent results on their influence on the adoption of CSA practices. While youthful farmers are viewed as having the likelihood to adopt CSA practices, older farmers are perceived to be less likely to adopt (Nyengere *et al.*, 2016; Negera *et al.*, 2022; O'Shea *et al.*, 2018). The education status has also been observed to have varied influences on the adoption of CSA practices (Kassa & Abdi, 2022; Okumu *et al.*, 2023). It is therefore not conclusive whether all significant drivers of risk to farmers are sufficiently represented for their influence on risk perception and consequently, the adoption of adaptative measures. The observation of such inconsistent outcomes influenced the use of a research design that allowed a better

understanding of the experience of smallholder farmers pertaining to their risk context and its consequences as they participated in the CSS programme. The uniqueness of the experience to context could be difficult to capture in a pre-set template and using a uni-method, but the selected mixed method design. These are pertinent observations in selecting the research design, as Hunter *et al.* (2019) argue that exploratory research is appropriate to use when there is vagueness or little knowledge and a need to gain familiarity with given concepts.

Table 3-1: Components of the research methodology

Specific objective	Research questions	Variables	Sampling approach	Data collection methods	Tools	Data analysis
To characterise the climate change and household risk context of smallholder farmers in Zvimba District	What is the description of climate change risks that smallholder farmer households experienced in Zvimba District?	• Types of climate change shocks such as: • Rainfall pattern • Temperature levels • Outbreak of crop & livestock diseases	Purposive sampling Convenience sampling Snowball sampling	• FGDs • Survey • Key informant interviews • FGDs	• Focus group discussion guide • Audio recorder • Notebook • Questionnaire	• Matrices of consensus • Venn diagrams • Internal validation • Latent content analysis • Descriptive, and inferential statistics • The Fisher's Exact Test • One-sample Wilcoxon signed rank test
	What is the description of household risks that smallholder farmers experienced in Zvimba District?	• Type of household risks • Food insecurity • Illness • Cost of living				
To assess the influence of household risks on farmer decision-making in the adoption of the combo product in Zvimba District	Can the influence of climate change risks in the adoption of the combo product be validated?	• Types of risks & influence on adoption decisions making				
	What influence did household risks have in the adoption of the combo product by smallholder farmers?					
To determine the scope of household risks impacted by the adoption of the combo product among smallholder farmers in Zvimba District	What pre-existing household risks were impacted by the adoption of the combo product in Zvimba District?	• Household risks impacted • Increase in production • Food availability • Increase in income • Satisfaction with services • Willingness to continue using services				

The integration of qualitative and quantitative methods was from the design of tools, selection of the sample population, collection of the data, its analysis and interpretation, as noted by Shorten & Smith (2017). As Halcomb (2019) states, the integration in mixed methods entails the concurrent but separate collection and analysis of qualitative and quantitative data with a final phase where both are integrated in interpretation. During data collection, FGDs and the survey were separately conducted. As argued by Dawadi *et al.* (2021), the use of qualitative approaches at the beginning allows for the in-depth understanding of issues, while concurrently shaping measures to be used in the construction of the tools for the quantitative part of the study. Initially, data was collected using FGDs, which allowed for identifying the key concepts related to experience and perceptions of the risk context of the farmers. The primary pursuit of the research was seeking answers to what, why, and how smallholder farmers considered when deciding to adopt the combo product. The qualitative method allowed for the determination of issues experienced by smallholder farmers and their influence on adoption decision-making. This was apt, as Sahin and Öztürk (2019) argue that exploratory sequential mixed methods can be used to find out about phenomena and identify themes and develop research tools. In addressing these, the study unpacked the type and scope of household risks that smallholder farmers were exposed to, and their significance in considering the opportunity to participate in the CSS programme. Though there are generic concepts on the climate change and household risk context, differences could be observed in how these are experienced in communities. It was therefore imperative that initial qualitative approaches were applied to allow for clarifying the risk context of the farmers in the study location. Similarly, in understanding the impact of adopting the combo product, the research design used is the most appropriate, considering the acknowledgment of the limited attention of the household risk drivers. Approaching the impact areas with an open intent to understand the range of areas of change is befitting, given that the risk drivers may not necessarily be aligned with the dominant conception underlined by climate change risk factors. **Error! Reference source not found.** illustrates the framework used in executing the exploratory sequential design.

Table 3-2: Study framework for exploratory sequential design

Phase	Process		Output
Pre-study/fieldwork	•Review of relevant literature •Visits to meet with ZFU & stakeholders at the District level & familiarise with wards targeted for fieldwork		•Key risk issues and CSA adoption •FGD guide •Questionnaire (partially coded) •Fieldwork travel plan
Phase 1 – Fieldwork	•Qualitative data collection, analysis & inferences (2 FGDs)		•Themes & codes •Profile of risk context & consequences & utilization of the combo product •Revised questionnaire (pre-coding)
Phase 2 – Fieldwork	Quantitative data collection, analysis & inferences (55 households)	Qualitative data collection (3 FGDs)	•Study findings
Phase 3 – Report writing	Interpretation & reporting (weaving)		•Study report

At the methods level, the exploratory sequential design included connections, which refers to the establishment of linkages between the qualitative and quantitative approaches through the sampling frame (Miller *et al.*, 2013). The smallholder farmers that participated in the FGDs were drawn from the same population of study as those who participated in the survey. This ensured that both the qualitative and quantitative samples shared the same exposure to the CSS programme, which was imperative for the alignment of findings. The subsequent quantitative data collected contributed to identifying, illustrating, and explaining the existence and significance of the relationships between climate shocks, household risks, and decision choices of the farmers, as revealed in the qualitative phase (Sahin & Öztürk, 2019; Dawadi *et al.*, 2021).

In the interpretation of findings and reporting, weaving is used, thus allowing for the integration of the quantitative and qualitative elements under each applicable theme. The qualitative and quantitative findings of the research questions are concurrently presented under each theme. One set of findings is used to provide clarification, expansion and contextualising the other, as argued by Dawadi *et al.* (2021). For example, the descriptive findings on the experience of smallholder farmer households, were better understood when weaved with the explanations from the FGDs on why these were areas of concern. The value of using mixed methods was the ability to triangulate the findings, which provided greater evidence. Shorten and Smith (2019) argue that the use of mixed methods allows for the research process to gather diverse perspectives that may further help in enlightening issues.

3.4. Population and sampling procedures

Purposive sampling was used to select the study location. The district and wards were purposively selected because that is where the CSS programme was implemented through a partnership between the Zimbabwe Farmers Union (ZFU) and a risk insurance provider between 1 August 2017 and 31 December 2019. The ZFU provided information on the CSS programme's outreach to farmers by each administrative ward. There was definite evidence provided by ZFU that the CSS programme had been implemented in Zvimba District and its Wards 5, 9, 10, and 20 which assured of a study population knowledgeable and experienced on issues within the scope of the study objectives and research questions. Initially, the four Wards were selected, but after engaging the Ward Councillors, Ward 5 was dropped from the study, hence only three remained.

The ZFU shared information indicating that there were 2,737 smallholder farmers who participated in the mobilisation activities of the CSS programme in Zvimba District. These farmers were treated as the target population for the study. Farmers attended the mobilisation activities of the programme, but this did not guarantee their adoption of the combo product. The 2,737 farmers potentially had some knowledge on the combo product, from information shared during the

mobilisation activities of the programme. However, they do not have lived experience to share on the use and impact of the combo product, which the study required. Smallholder farmers who attended the sensitisation and mobilisation meetings but did not buy the combo product are excluded from the sampling frame. The primary requirement for inclusion in the sampling frame was a smallholder farmer that resided in the study location and enrolled and used all or any part of the combo product promoted by the CSS programme. As argued by Andrade (2021) these are the characteristics that made them fit the purpose and scope of the study. The study collected data from smallholder farmers who used the combo product to ensure an information-rich sample that would share appropriate and valuable experience of relevance to the objectives of the study (Campbell *et al.*, 2020; Mweshi & Sakyi, 2020; Andrade, 2021). The study had a narrow focus on household risks and their influence on the decision to adopt the combo product promoted by the CSS programme and over a precise period. These are factors that Malterud *et al.* (2016) argue could be considered in deciding on sample size, with the intent of executing an information power research exercise.

3.4.1. Key informant interviews

Key informants were selected for their role and awareness of the design and implementation of the CSS programme. They provided clarity and insights on the CSS programme design, operational areas, outreach, implementation experience, and access to information. The ZFU provided the information on the key informants that included staff from ZFU, Agriculture extension services and the risk insurance provider. In the implementation of the CSS programme, the Agricultural, Technical and Extension Services (AGRITEX) staff at the Ward level supported farmers with extension services complementing the information tips they received through mobile phones. The findings from the key informants were also used to develop questions for the FGD guide, and questionnaire.

3.4.2. Focus group discussions

A sample of 6 FGDs was planned after considering the narrow focus of the study, existing literature on the research topic, the preciseness of the sample, as well as the representation of each ward. In planning for this study, provision was made for an additional 3 FGDs to further increase data saturation levels. Consideration was also made of evidence from other research where conclusions made are that the first 3 FGDs cover 84 % of codes (Young & Casey, 2018). The target for each FGD was to have 8 participants per session, with an equal representation of women and men who were voluntarily willing to participate. As argued by Hennink *et al.* (2017), one factor that could influence the sample size is the characteristics of the study. The study sample is based on a special group of farmers that participated in the CSS programme and were asked very specific questions on the adoption of the combo product. There are existing theoretical frameworks on the adoption of adaptation measures with some already having coverage of

elements related to the social and economic factors of individuals. The MPCCA model already considered the contribution of individual risk experience, cognitive bias, and resources such as time and money in the adoption decision-making process by farmers (Grothmann & Patt, 2005).

3.4.3. Survey research

Though the CSS programme had initially been reported to have reached 146 adopters of the combo product the list provided by ZFU had 101 smallholder farmers in Ward 9 (47), Ward 10 (26), and Ward 20 (28). A meeting was held with ZFU District Office and Agriculture Extension workers to validate the names of farmers using the officials' knowledge of the local areas. The validation resulted in the identification of some farmers that were listed under the wrong Wards, duplicated farmers and others who were no longer available for different reasons. The validation process resulted in adjustments to the list of each ward to 37 smallholder farmers in Ward 9, and 23 in Ward 10. After the validation convenience sampling was used to select farmers that had participated in the programme and attended the community meetings organised in Ward 9 and 10. In each village, farmers that participated in the programme knew each other and extended invitations to the community meetings among themselves. Farmers confirmed that some farmers were no longer available as their circumstances had changed including relocation, death and changed contact numbers. The validation of farmers in Ward 20 had complications as the random list had detail that could not be easily used to identify the farmers which included the ID number, date of birth, and sex. The alternative used was snowball sampling, that started with agents used in the CSS programme. During implementation, the programme used agents to mobilise and register participating farmers. Three of these agents were still available and a meeting with them identified only 14 farmers that participated in the programme. A meeting was organised with the 14 farmers to confirm their participation in the programme and willingness to participate in the study. The farmers were requested to contact and invite other farmers that were not in attendance, but they knew had participated in the CSS programme. In the follow-up meeting, an additional 9 farmers attended and were included in the list, resulting in a total of 23 that were covered by the survey.

3.5. Data Collection tools

The data collection methods were key informant Interviews, focus group discussion, and survey.

3.5.1. Secondary sources

Available secondary sources of information with details on the services provided to farmers were used. The ZFU provided some project documents that included the contract, a 2019 Project Monitoring Report, and Impact Assessment Report. In the documents, the combo product and its services are described. In addition, other publications available on public domains were reviewed (Kadzamira & Ajayi 2019; Ajayi & Kadzamira 2020; Parwada & Marufu, 2023). These documents

provided the necessary details on the supply-side interventions. The study was focused on what influenced the adoption of the combo product and less so, on how this was adopted, which could be extracted from documents shared by the ZFU.

3.5.2. Key informant interviews

A key informant guide with questions related to awareness and involvement in the CSS programme was used for the interviews. The guide also had questions on other institutional partners known to have participated in the programme. The researcher would follow-up on the responses to the questions.

3.5.3. Focus group discussion

The development of questions for the FGD guide was informed by the initial review of literature on risk and drivers of adoption and the impact of CSA practices. The review of the literature to some extent aided the external validity of the study findings. The focus group discussion (FGD) tool was used for the potential it presented to generate rich information from the range of experiences, observations, perceptions, expectations, behaviours, and ideas that participants shared about the subject under research (Cyr, 2019; Busetto *et al.*, 2020; Gundumogula, 2020). As Acocella & Cataldi (2021) argue, when FGDs have representation of individuals that share an identity, this is a fitting condition for the collectively shared knowledge to be analysed.

The structure of each FGD included initial introductions between the participating farmers and the moderator. This was followed by an explanation of the study background, including its academic purpose, the challenges, and questions with the adoption of CSA practices, and the protocols followed in getting the approval from the authorities. The researcher asked generative questions and as participants responded, the matrices of consensus were completed to track who and of what gender was contributing during discussions. Some of the generative questions related to community knowledge, observations and experience with climate change-related stressors and household risks before the launch of the programme.

The smallholder farmers also discussed background questions on services they previously used and were still using, the impact they experienced, the areas they recommended for improvement, as well as how these influenced adoption decisions. This background discussion contextualised the relevance of launching the CSS programme. Importantly, this allowed the participants to recall their situation and experience before adopting the combo product and the association with risk and decision-making. Further, this allowed the validation of awareness and experience with climate change risks by the smallholder farmers. As argued by Nyumba *et al.* (2018), this would

highlight the importance of the immediate environment and experience of the farmers, as this shaped their beliefs, mental constructs, and interpretation of issues. Allowing participants to discuss and recall the risks they experienced before participating in the programme would give them confidence in the moderator's understanding of their circumstances.

Though smallholder farmers resided in the same Wards they were from different households, and yet occasionally interacted on farming-related activities which allowed for vibrant discussions and diverse perspectives on expectations, experience, behaviours and ideas (Cyr, 2019). All the farmers that participated in the FGDs had enrolled for the combo product for which they had varied utilisation experience. The participation and familiarity of the farmers with the CSS programme allowed for immediate affirmation and correction of certain common facts on issues related to types of services received, when, where, and how delivered. The interjections and choruses during discussions provided immediate indications of agreement and differences on issues among the farmers.

The researcher constantly reviewed the matrices on the pattern of contributors to discussions and used this to manage how and who contributed. In instances where some individuals had not contributed to discussions, the researcher intervened by directly requesting those who had not spoken to be given a chance to voice their perspectives. In other instances, the researcher directly requested those whose views had not been expressed to speak. Conversely, the researcher would direct contributions to be made following the seating pattern, which assured that every participant had the chance to speak. In some instances, the researcher used a ball that would be given to the first person speaking who was requested to pass it on to the next person that had not spoken until all participants had their voices heard. In addition, when asking follow-up questions, the researcher would directly request the first responders to be those whose voices had not been actively involved in previous questions and discussions.

The researcher moderated each FGD using open-ended questions with follow-up probing which allowed the farmers to discuss and exchange in-depth individual and group expressions of experience with the adoption of the combo product. The questions in the guide stimulated discussions on the opinions, knowledge, and feelings of the smallholder farmers concerning their experiences. As argued by Nyumba *et al.* (2018), the moderator facilitated the creation of an environment that allowed diversified participation to reduce the risk of biased findings. This included using the consensus matrix and Venn diagrams to track patterns of contributions during discussions and prompting contributions from individual and diversified participants. A voice

recorder was used to capture the discussions while transcription notes were used to capture the pattern of exchanges and noting areas for follow-up questions.

The FGDs were used to review the appropriateness and comprehension of the questions in the FDG guide and the questionnaire. The types of questions in the qualitative part of the study mirrored the questions in the questionnaire. An added value from the first FGDs was the revelation of terminology locally used and understood on various content issues on the research topic. This included terminology on climate variability and change, combo product and the types of services received, and where and how they were delivered. This helped in bringing clarity and efficiency in subsequent FGDs and the survey.

3.5.4. Survey

The review of literature also contributed to the development of the questionnaire. At the start of the study, the questionnaire was designed with two categories of questions. The first were questions with pre-coded responses, while the second were not pre-coded. The first had predetermined responses on age range, gender, and well-being status of the household head. The second were experiential and required the codes to be developed out of the lived experience and opinions of the smallholder farmers. The examples of such questions were on climate variability and change stressors and household risks experienced in the community, and the impact areas of the combo product. The FGDs were used to inform the pre-coding of response options to questions in the questionnaire. After the FGDs, the questionnaire was refined including rewording questions, removing duplications, and pre-coding responses to all questions.

A funnel approach was used in designing the questionnaire. As posited by Taherdoost (2022), this entailed having at the beginning of the questionnaire more generic questions on the demographic profile, climate change shocks and household risks and services in the combo product. These general questions gave context to the subsequent specific questions on the adoption and impact of the combo product. The questions that followed collected more in-depth data on each component of the combo product, whether it was used, its role in influencing adoption decision-making, the impact, and likelihood of continued use. The survey filled and complemented the limitations of the qualitative method regarding statistical comparison and association of findings, explaining and demonstrating the prevalence of influence, perceptions and behaviours.

The questionnaire included a combination of questions, with some requiring responses to be captured using checklists and rating scales. The checklists were used to establish the different types of risks of the smallholder farmers before the implementation of the CSS programme and the services in the combo product that were used. The 5-point Likert scale was used for the smallholder farmers to rate their perception on the influence of the household risks on decision choices and how satisfied they were with the combo product. The rating options included 1=Strongly agree, 2=Agree, 3=Neutral, 4=Disagree and 5=Strongly disagree. Binary questions were used, for example, when the farmers were asked to select either 'Yes' or 'No', whether they had used the services in the combo product and if these influenced their adoption decisions. The questionnaire collected data that allowed for statistical description and comparison of variables and by so doing enhancing, illustrating, and clarifying findings from the FGDs (Schoonenboom & Johnson, 2017).

A research assistant with experience using mobile data collection platforms was hired to work with the researcher to set up the questionnaire on KoboCollect, an Android phone-based application. Enumerators hired had prior experience using mobile phone-based data collection applications, with four having used KoboCollect, while two had used Open Data Kit, both of which were useful experiences. The KoboCollect application allowed for off-line data collection and online submission which was done at the end of each day by the enumerators. Two trainings of enumerators were conducted, one for the four enumerators for Wards 9 and 10 and another for the two in Ward 20. The purpose of the training was to have enumerators understand the meaning and the different responses to the questions, and how to complete and submit completed questionnaires. The training of enumerators was also used to harmonize the understanding of key terminology in the local context. There were minimal challenges experienced with the use of the KoboCollect application by the enumerators. The use of trained enumerators during the survey had the advantage of assuring consistency in both explanation and understanding of the questions and capturing and completeness of data. The household was the basic unit of study, and the questionnaire was administered to household heads that directly participated in the CSS programme.

3.6. Data analysis

Data was captured as audio recordings and written notes. A systematic process in the analysis of findings was followed in multiple phases. The unit of analysis was both phrases and sentences. The identification of meaning units started during the data collection process at FGDs. At each respective FGD, the researcher took note of key phrases and sentences that were deemed relevant for meaning units and coding and the research objectives. Taking notes allowed the

researcher to ask follow-up questions that contributed to providing clarification to the meaning units as discussions were evolving. The matrices of assessing the level of consensus were used to capture and analyse unanimity and disagreement on issues that were discussed by the FGD participants. The combo product was meant for households and not collective use and the expectation for the research was diversity of experience with a combination of both agreements and disagreements. During the FGDs, tables prepared before the session were used to capture the pattern of contributions by each participant and their gender. The data was captured using pseudonyms assigned to participants, which included the gender, and an assigned number based on the total number of participants per FGD. The codes included "M" for male, "F" for female, and a figure number from "1" to the highest number for male and female participants in the FGD. As participants made contributions to discussion topics, a code was used to capture the views using codes adopted from Onwuegbuzie (2009). The codes were A (where the participant indicated verbal or non-verbal agreement to an issue), D (for verbal or nonverbal expression of dissent to an issue), SE (when a participant provided a significant statement or example in their agreement to an issue), SR (when a participant provided a significant statement or example for their dissent to an issue) and NR (in instances when a participant responded either agreeing or in dissent to an issue). The number of participants per session was listed on the first column while the questions being discussed were on the first row. The code representing the nature of a participant's contribution was recorded against their pseudonym code. As Onwuegbuzie *et al.* (2009) argue, it is important to analyse how many participants were agreeing, not agreeing, and not contributing to issues and integrate these with the qualitative findings of the study. This allowed for the analysis and demonstration of the representation of participation and diversity of voices during discussions. As individuals were discussing, the matrices of consensus captured who and their gender were contributing, allowing for both majority and minority and vocal and less vocal voices of the smallholder farmers to be represented. During and after each FGD, the matrix was reviewed and a determination was made on the pattern of participation by individuals, at the group level and across different groups. During the review of the FGD transcripts, the researcher counted the types of codes, and the number of instances recorded for each during the FGD, to determine areas of agreement and dissension.

Venn diagrams were used to track and assess the pattern of participation in discussion topics by both gender and number of contributors, including who responded first and contributed to a particular issue. The pseudonyms used to collect the data included a capital "M" for instances where a male was the first to contribute perspectives on a topical question or issue while a small "m" was for instances where the male contributed to a topic already raised by another participant. A similar application was made for female participants with the use of the capital "F" and the small

letter 'f'. The researcher prepared Venn diagrams that were not labelled. The labelling was done as meaning units were mentioned, such as adjusted meal frequency, high funeral expenses, unaffordable education costs, and unaffordable agricultural inputs. Where a female participant was the first to contribute to high funeral expenses, their gender was captured in the respective circle with a capital letter "F". All subsequent contributors to the same topic were captured using either small letters 'f' or 'm'. The Venn diagrams allowed observation and comparison during and after the FGDs of patterns for tendencies toward domination and exclusion of participants by gender. During the FGDs, the Venn diagram allowed the research team to prompt and give chances to the less engaged farmers to participate in discussions, in conformity with observations made by Onwuegbuzie *et al.* (2010) on how the tool could be useful for this purpose. During and after the FGD, the review and analysis of the Venn diagrams allowed the researcher to observe the role of male and female participants in initiating and backing discussions. Given the dominant role of women in agriculture and the potential effects of patriarchal cultural values and norms on women's participation in social processes, it was important to track diversity and representation of voices in the discussions.

The preciseness of the research focus narrowed the meaning units, codes, and themes. By the third FGD the results generated were relevant to the research objectives and were being repeated, with minimal edits and additions. This indicated an inclination towards high data saturation, but the study persisted with the fourth and fifth FGDs to reinforce the findings. Hennink *et al.* (2017) cautioned on basing saturation on themes without paying attention to the meaning and importance of the issues in the context of the research objectives. The meaning units, themes and codes generated from the data were assessed on how they contributed to explanation, expanding, clarifying, and diversifying perspectives related to risk context, adoption, and impact of the combo product. The decision to cancel the sixth FGD that was disrupted by rains was informed by a determination that this would not add new meaning units and codes to what had already been collected. The researcher was confident that the cancellation would not affect the outcomes of the research process.

Latent content analysis was used to analyse the FGD findings. In broad terms, Vaismoradi *et al.* (2013) posit that content analysis can be used to understand why a given population is using or not using a service. It was considered most appropriate to use content analysis for this study, given the need to understand why smallholder farmers adopted the combo product. The study was informed by existing research that included the well-documented influence of climate change stressors as drivers of adoption decision-making and the less profiled role of household risks. The

two provided a basis for the partial deductive development of categories while the identification of new meaning units inductively emerged from the data. Some categories related to climate change stressors, food and health risks could be deductively drawn from the literature. There were some categories relating to perceptions of parenting, self-esteem, and funerals and their association with decision-making that had not been factored deductively, but inductively from the findings.

The data was prepared before analysis, and this involved an initial repetitive playing and replaying of the audio recordings for in-depth familiarisation with the data. As the recordings of the first and subsequent FGDs were being reviewed concurrently, meaning units were being identified and noted in a notebook. Following this, each recording was typed into word documents. In the process of typing, notes were made of emerging meaning units and themes from phrases and sentences by writing. According to Kleinheksel *et al.* (2020), these were short narrative tags that represented the prominent meaning of relevance to the research. During the transcription process, highlights and comments on indicative meaning units were made to phrases and sentences of relevance to the formulation of codes in subsequent phases. The typed documents were further re-read to reinforce familiarity with the data. As Sundler *et al.* (2019), argue multiple open-minded readings of transcripts are essential to practice for in-depth familiarity with the findings, with the same applying to the repetitive replaying of audio recordings.

To test and review the consistency of the meaning units, the researcher reviewed these across the notes taken for all FGDs. The review considered the similarities, differences, consistency, representation, and new pathways of the phrases and content of the meaning units. Further reading of the analysis notes allowed for the reaffirmation of meaning units, codes, and the creation of categories and themes. After the preparation of the data, the deductive content analysis flow outlined in Figure 3-3, with examples of analysed findings, was used as an adaptation to a suggestion by Bengtsson (2016).

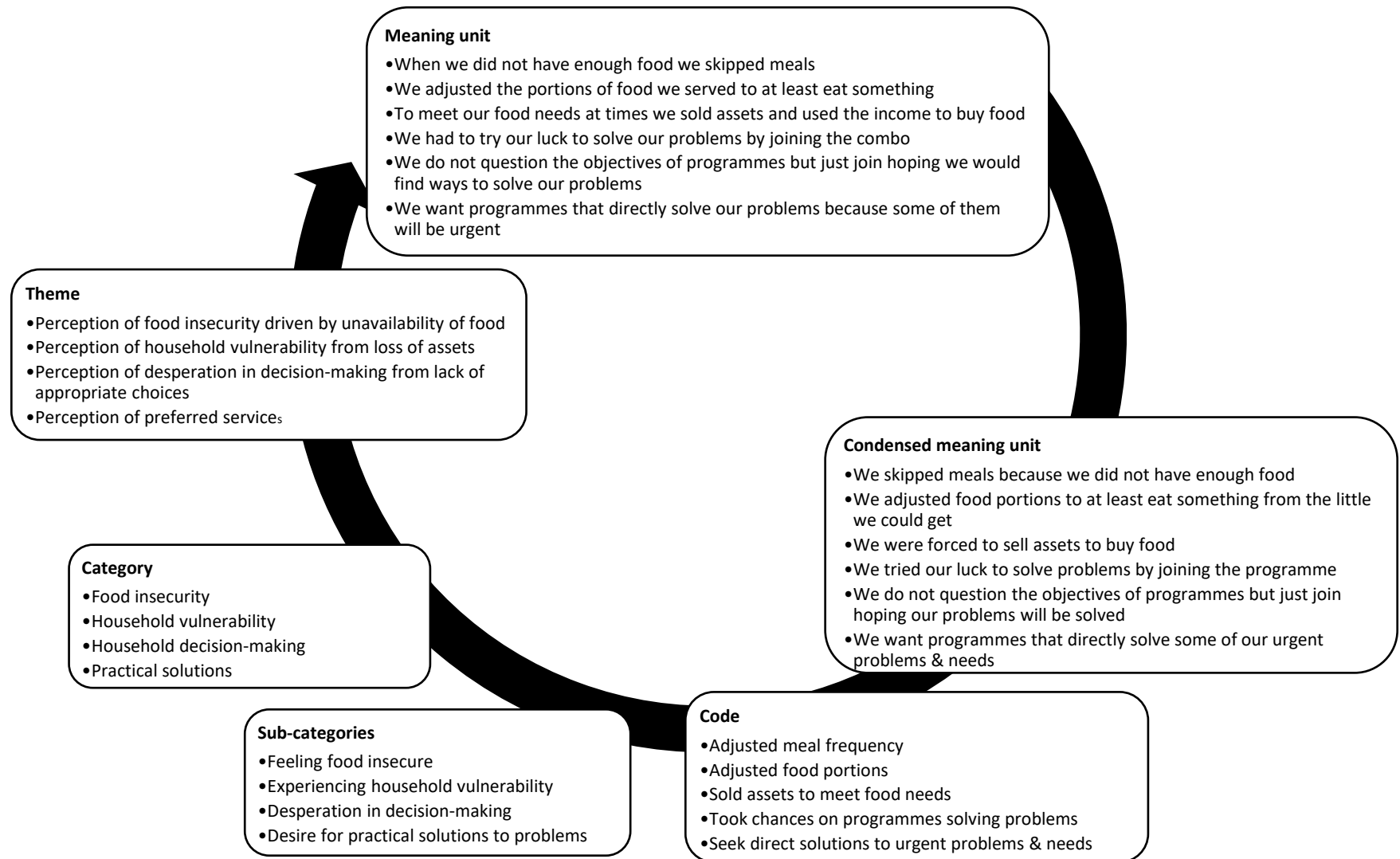


Figure 3-3: Illustration of the flow of content analysis on extracts from the study data

Source: Researcher

As the example in **Error! Reference source not found.** shows, meaning units were further analysed and grouped into codes, that were synthesised into sub-categories and based on their similarity, grouped into categories and subsequently, themes. The synthesis process at different levels was based on identified points of common reference in the content meaning (Vaismoradi & Snelgrove, 2019).

At the end of each FGD, an internal validation of the findings was conducted. This involved the researcher presenting to participants a summary of the key points that were discussed and their relevance to the research objectives and questions. Participants were requested to confirm, change, and add to the findings.

The data for the survey collected using KoboCollect was saved and downloaded in MS Excel format where the necessary cleaning was conducted. The data were analysed using StataCorp's STATA, a statistical software package for data analysis. STATA was selected for use in analysis after considering its strong capability to clean and organise data, application versatility when conducting both descriptive and inferential statistics and where needed, easy application by others, thus enhancing transparency and accountability. In addition, consideration was made of the fast data processing capability of STATA, particularly with a small sample size. STATA was used for the Fisher's Exact Test to determine whether there was or was not a non-random association between categorical variables.

The survey data was manipulated for various purposes including descriptive, and inferential statistics. In the descriptive methods, frequency analysis was applied to the occurrence of responses on most datasets. Descriptive tabulations such as tables, graphs, and charts, were used for analysis and summary presentation of the frequencies and percentages to allow for comparison of the findings. The Fisher's Exact Test of association was used to test the relationship between selected categorical variables. The analysis was meant to contribute to the study's Objective 2: To assess the influence of household risks on farmer decision-making in the adoption of the combo product in Zvimba District. The independent variables used for analysis included gender, education status, well-being status, and age of the household heads. The $P < 0.05$ was used for determining the statistical significance of the association between analysed variables. The Fisher's Exact Test was used after observations were made of several datasets whose cell counts had less than five (5) responses and the selected test was considered the most suited for analysis.

For items where the respondents were asked to indicate the extent to which they agreed or disagreed with the given statements, a one-sample Wilcoxon signed rank test was used to determine whether the median value of the responses was significantly different from the hypothesised value of 3 (neutral). If the median value was significantly less/greater than 3, then this was interpreted to mean that the respondents disagreed/agreed with the given statement.

3.7. Ethical considerations

The University of Venda's Research Ethics Committee approved the study. The consent for participation in the research by stakeholders was an essential ethical step for access to information and transparency of the process and outcomes. Conducting the research in locations where there was agreement with key stakeholders was imperative. The permission to conduct the research was sought from the ZFU, the Local Government District Coordinator's office and AGRITEX District Office. The smallholder farmers who participated in the CSS programme are members of the ZFU. It was important protocol to have the ZFU's approval, and this was granted after communication that included letters, emails and virtual and face-to-face meetings. The communication shared the research objectives and questions and the profile of the farmers who were targeted as the sample. In response the ZFU provided more details on the CSS programme outreach in terms of farmers and their locations. The information was very important in subsequent approval required from the Local Government and AGRITEX District Offices. The researcher met in person, but separately, with the Local Government and the AGRITEX District Offices to present the scope of the research and seek their approval for the research. In the initial face-to-face meeting with the Local Government Office, verbal consent to the study was granted but they required for formal communication to be made. This communication was considered important to have a record of the purpose of the research, timeframe, and target locations. The district office would be able to respond to any questions raised on the research within the scope of the contents of the letter while they would not do so for deviations. The researcher met the AGRITEX District Office to explain and discuss the research and obtain the approval to use their staff in the study locations during field work. A face-to-face meeting with the AGRITEX District Office resulted in a verbal approval and request for a letter detailing the research and request for support. The letters to the Local Government and AGRITEX District Offices were submitted, after which both granted approvals for the research.

During the entry community engagements with the Councillor for Ward 5, they declined to grant permission for the study to include this location. The Councillor expressed concerns over some issues that had not been resolved by the time the CSS programme closed out. The Ward was

dropped from the research, without replacement as there were no other wards in the district that could be included.

At the start of each survey and discussion, the academic purpose and focus of the research were explained. Prior to seeking the consent to participate in the study survey and FGD participants were requested to ask question which were responded to. The survey and FGD participants were informed at the onset that only those who voluntarily agreed to participate were to be involved in the study. The researcher did not require group-level voluntary participation, the selected farmers maintained their right to individual voluntary participation. The survey and FGD participants were informed of their right to stop or withdraw from the research process without any prejudice. The researcher did not provide or promise any incentives, or material support to respondents, and this was explained at the start of each session.

It is necessary to elaborate on how anonymity was safeguarded and how the data collection and analysis and reporting protected the privacy of participants. As Kang and Hwang (2023) argue, when the identity of research participants is not revealed, this enhances the chances for genuine and objective findings. At the beginning of each survey, as part of the request for informed consent for voluntary participation, the researcher explained the type of personal data to be collected and how anonymity and confidentiality were to be applied, and the importance of preventing any harm to participants arising from their participation in the research process. The researcher explained how in the analysis, reporting, and presentation of the findings the personal details of participants were not going to be revealed and traceable to the sources. This included the demographic characteristics of participants such as their age, gender, education, and income status. To ensure that this data would not be traceable to the personal identity of any of the smallholder farmers in the analysis and report writing, all the data was aggregated, making it impossible to be tracked to individuals. The researcher did not collect personally identifying data such as the national identification number and the day, month, and year of birth, as these were not necessary for the study.

The data on wards, villages and homesteads was managed in analysis and reporting, to assure the anonymity of study participants. The study did not collect names of homesteads and villages, but only those of the wards. In Zimbabwe, a ward is subdivided into villages, and within each village, there are an estimated average of 35 homesteads (Chigwata, 2016). A ward was considered expansive enough and contained a population larger than the farmers which would make it difficult for individuals to be identified particularly with the limited personal details that

were collected. In the absence of details related to the name of the village, homestead, and names of individuals the anonymity of farmers was assured. Sharing information on precise household income can be sensitive and considered private, with some individuals having reservations. To avoid interfering or raising concerns about the privacy of such information, the study only requested individuals to estimate their monthly incomes using ranges than specific figures.

The names of respondents in the survey were recorded but were not used in data analysis and reporting. The anonymity of names was explained to respondents and participants in focus groups. The names were recorded as provision for the likelihood of follow-up in the event of any clarification required on aspects of the data. There was no such requirement for follow-up with any farmer who participated in the study. The names of the participants are recorded in an Excel file that is password-protected to restrict access to the data. In the data analysis file, the names of the survey participants were decoded to ensure they were not identifiable. In the FGDs, the names of the participants are not recorded and remained anonymous. At the beginning of each FGD session, the researcher assigned codes that were used as pseudonyms. At each FGD, male participants were identified by the letter M for Male and number (e.g. M1, M2, M3) in ascending order, up to the total in attendance. A similar format was used in assigning pseudonyms to female participants, F for female and a number. The pseudonyms were assigned by the seating order of the participants during the FGD for easy reference in monitoring and managing the inclusion of contributions and follow-up probing during discussions. To further assure participant anonymity, the pseudonyms are not used in cases of quotations in verbatim. In reporting where quotations are used a generic gender-linked reference is used for example "Male participant at Povo FGD" or "Female participant at Povo FGD". During discussions, participants mentioned names of fellow villagers and villages with whom there was experience relevant to making some discussion points. Similarly, these names are not used in analysis and reporting.

3.8. Study implementation procedures

The process followed in implementing the research is summarised in Figure 3-4.

3.8.1. Stakeholder engagement and community entry

Community engagement was a structured process. Initial contact was made with the ZFU National Office for the approval for their smallholder farmer members to participate in the research, before other stakeholders were engaged. ZFU assigned an overall contact and support person who in turn introduced the researcher to the District Office that offered to lead in coordinating the meetings and introductions at district level. Meetings were facilitated with the Local Government and AGRITEX District Offices and the Parliamentary Constituency Office. The Local Government heads the district with key responsibilities including coordinating, planning and implementation of

development initiatives. The protocol in Zimbabwe requires research activities implemented in communities to be approved at the Local Government District Office, which in turn will notify other structures in the district. The researcher set up an in-person meeting with the Local Government District Office during which the key areas of interest and concern included the importance of feedback to programmes to inform future designs and consultations with farmers. Reference was made to research that had been conducted in the district without any feedback given to approving authorities. The lack of feedback meant authorities lacked evidence to use research in reviewing and guiding new programmes. There was acknowledgment that climate change had already impacted the district and in response some CSA programmes had been implemented. The low number of adopters of CSA practices was noted as an area of concern and needed stakeholders to collectively explore ways to address the barriers.

The AGRITEX District Office was approached to support the fieldwork as they have responsibility for providing farmers with extension services. They are knowledgeable of existing activities planned for farmers which will be important for coordinating activities such as research fieldwork. Extension workers have presence at the Ward level, and this made them a more effective channel for communicating with and mobilizing farmers. They have regular contact with farmers and know the location and names of most farmers. The AGRITEX District Office assigned Extension Supervisors that covered the wards targeted for the study to provide support in communicating and mobilising farmers for meetings. AGRITEX District Office acknowledged the validity for questioning the sustainability of CSA practices considering programmes that have been implemented in the district. Different agencies had promoted CSA practices and, in some instances, repeated the same practices with the same farmers. The view was that it appeared there was no consideration of lessons from past programmes to improve on new initiatives. Two follow-up meetings were organised with the ward level extension workers. The purpose was to introduce the research, sample, and the expected support in the research process. In the meeting, the researcher made a request to the extension workers for assistance with recruiting enumerators from local communities who might have participated in past assessments and with experience using mobile phone-based data collection tools. The extension workers expressed their availability to support with data collection as they had experience using mobile phone-based data collection tools from past rural livelihood assessments. The meeting also reviewed the questionnaire for clarity and appropriateness of the questions and vernacular terminology to the study context. In addition, the questionnaire loaded on KoboCollect was pretested to be certain of the functionality of the response selection features.

A meeting was also held with the Constituency office of the local Member of Parliament to inform them about the project. There was no approval required from this office, but creating awareness on the research process. The researcher noted that occasionally, the constituency office organises community meetings that require coordination with activities such as research work. The importance of following up on projects to understand better their performance was considered an important piece of work by the Constituency Office.

A meeting between the ZFU District Office and the researcher planned the community level engagement and fieldwork and key communication messages. The community engagement plan included meeting and getting Ward councillors to consent to the research. As the ZFU had led the CSS programme implementation engagements with the local leaders, they requested to lead the consent engagements with the councillors. The meetings with councillors were conducted ahead of the community mobilization activities that were led by the Extension workers. The ZFU coordinating with extension workers secured community-level appointments with the farmers.

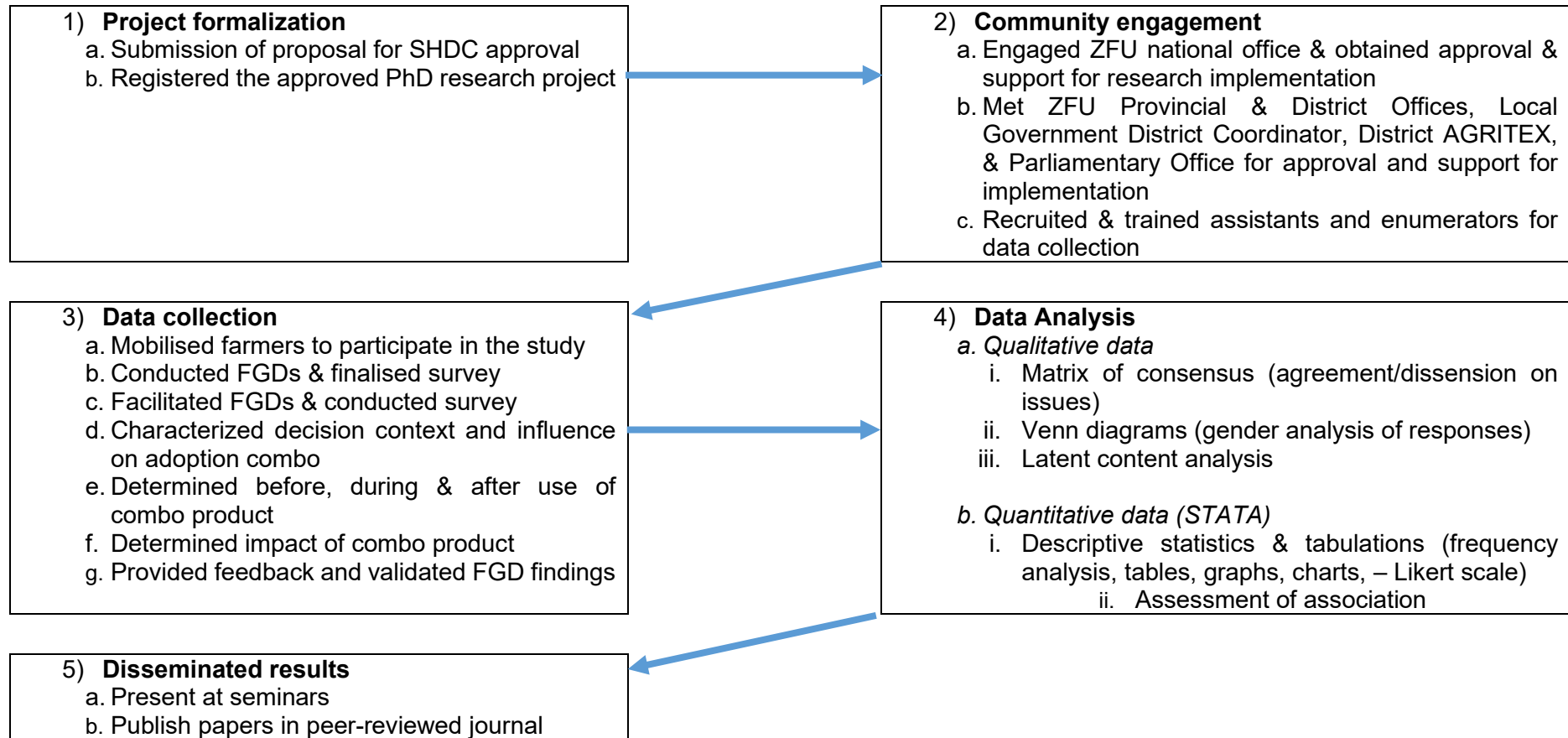


Figure 3-4: Research road map

Source: Researcher

3.9. Research and methods limitations

After considering the exploratory nature of the study, the use of a small sample size was regarded appropriate to allow for both focus and depth in the findings, which would have not been possible with a larger sample. The study drew the sample from a homogenous population by virtue of being members of the ZFU that participated in the CSS programme. The farmers had adopted the same combo product which was the core focus of the research. The likelihood of the farmers sharing diverse experiences, but with narrow focus on the combo product was very high. By the homogeneity, and as argued by Gumpili and Das (2022), small sample sizes could be used as there would be less standard deviation in the findings. The homogeneity of the sample would aid the validity of the study findings. However, as pointed out by Taherdoost (2016), small sample sizes have the downside in that their findings would not be generalised to the population. The study gave prominence to revealing the presence or not, of household risks that could be associated with risk perception and the adoption of adaptation measures. The revelation from the findings paved the way for future research that could focus on generalisability.

The use of FGDs as a data collection tool exposed the research process to unforeseen logistical circumstances that necessitated the suspension of field activities which could be less experienced or managed differently with approaches targeting individuals. The study was undertaken during the rainy season. The expectations and signals for the likelihood of rains affected both attendance and potential anxiety during the FGD processes. There was the likelihood of the attention span of farmers being affected in instances where signs of rains were more apparent. This was more evident in Wards 20 and 10, though the rains did not fall during the day, but in the evening. Further, when rains fell for more than two hours in Ward 20, this affected the participants accessing the meeting venues. Immediately after the rains, the farmers attended to crop planting activities that could not be delayed for the FGD session. The planned FGD session was cancelled, without affecting the study objectives, as previous FGDs had gathered adequate findings. The survey data collection in Ward 20 was extended by an additional three days to make up for the effects of the disruption caused by the rains.

Convening community members in group-based research processes was affected by other ongoing activities in the wards. The study was undertaken at a time when free agricultural inputs were being distributed across the district. Though the communities were given time that they were supposed to convene at distribution points, the schedules were never followed. At most sites, communities waited for not less than 3 hours for the inputs to be delivered at the distribution points. The initial plan was to allow the input distributions to be completed first and then execute

the research process after. However, because of the delays in the delivery of inputs, discussions and survey started with the flexibility for suspension whenever the inputs were delivered. At 4 of the sites, discussions were completed before the delivery was done. It was only at one FGD site that the delivery truck arrived in the middle of an FGD, and the session was put on hold. The session resumed after 10 minutes as the FGD participants were informed that there was need for more time to organise the inputs before the distribution.

The use of FGDs raise issues on the representativeness of the diversity of voices among the participants. This is particularly pertinent, given that even in the smallest groups personalities differ, with some being more vocal, expressive and proactive than others. In the event of FGD facilitators not being alert, a few individuals could dominate the conversations even if their views are not necessarily representative of the group. The dominance of a few individuals could lead to biases in the FGD findings. The use and impact of the combo product had a mix of experiences among the farmers, that included being highly animated because of either the positive or negative benefits. Allowing the animated views from the farmers who had positive experiences could miss the views of those with deviating experience and this required alertness and management. The matrix of consensus and the Venn diagrams were helpful tools in monitoring the diversity of contributions. On occasions, patterns of participation observed in these tools were conveniently used to prompt other FGD participants and even remind the group of the need to allow other voices to be heard. On some questions, requests were made for each participant to make at least a single point at a time, to allow others to contribute.

3.10. Chapter summary

This chapter presented the geographical context, Zvimba District, where climate change stressors had been experienced and CSA practices implemented, providing the ideal context for seeking answers to the research questions. The study was exploratory and used sequential integrated mixed methods to understand the breadth of climate change stressors and household risks of smallholder farmers, and their influence as drivers of risk and decision-making to adopt the combo product. The mixed methods approach allowed for responses from the FGDs to inform the development of the questionnaire, as well as to support and bring clarity and explanation to the quantitative findings (Dawadi *et al.*, 2021). The alignment of questions in the FGD guide and those in the questionnaire strengthened the triangulation, illustration, clarification, comparison, and explanation of the study findings, aligning with Creamer (2018) on the value of mixed methods approaches. A combination of sampling approaches was used as an adjustment to the change in the circumstances of farmers that participated in the CSS programme and the desire to allow for an information-rich study.

Securing the approval of ZFU and local government authorities for the execution of the fieldwork was an important step in accessing communities and the study sample. Maintaining flexibility to adapt the field work schedule was imperative, given the occurrence of unforeseen competing processes and unavoidable natural events. The farmers who participated in the study were drawn from three wards under the Zvimba District. The study included five FGDs and one survey with 55 smallholder farmers involved in crop and livestock production. An FGD guide and electronic questionnaire were used for data collection. The analysis of the FGD findings commenced during data collection and included the use of the matrix of consensus, Venn diagrams, latent content analysis, and internal validation. STATA was used in the analysis of the quantitative data that included both descriptive and inferential statistics. The ethical considerations applied during the study included maintaining the anonymity and confidentiality of participants, obtaining prior informed consent and voluntary participation, aligning the research to a problem prioritised by participants, and clarifying the purpose of the study.

CHAPTER 4 RESULTS AND DISCUSSION

4.1. Introduction

In this Chapter, the purpose is to present all the findings of the study.

The adoption of CSA practices by smallholder farmers has been driven by climate change risks on food and agriculture systems that include variation and extreme rainfall and temperatures, hailstorms, flooding and wind, droughts, and cyclones (Hatfield *et al.*, 2020; Shah *et al.*, 2021; Aggarwal *et al.*, 2022). The study explored whether there were no household risks that could carry a similar weight as the climate risks in instigating smallholder farmer risk perception.

In view of the above, the chapter proceeds as follows: presentation of the results on the characterization of the climate change and household risk context, followed by those on the influence of the risk context in the adoption of the combo product and finally the impact of the combo on smallholder farmer households. In each of the three sections of this Chapter the quantitative findings are presented concurrently with the relevant qualitative findings. In some of the questions in the survey smallholder farmers were allowed to select more than one response depending on their experience. For example, some smallholder had experienced more than one climate risk, household problem and used more than one service in the combo product. In these instances, they would have multiple answers resulting in the total count of the responses being above the 55 smallholder farmers that were interviewed.

4.2. Characterising the climate change and household risk context of smallholder farmers in Zvimba District

This section presents a description of the risks experienced by smallholder farmers before the CSS programme was launched. The focus was on the types of climate change risks and household risks as these have varied prominence in literature on risk drivers, risk perception, and adoption of CSA practices (Cavanagh *et al.*, 2017; Fayso 2018; Ahmed *et al.*, 2021; Zhou *et al.*, 2022). How the circumstances influenced the decisions of the farmers in the adoption of the combo product, is dealt with in Section 4.2 of this chapter.

4.2.1. Socioeconomic profile of the sample

The survey had most of the 55 farmers residing in Ward 10 (21, 38.2%), followed by Ward 9 (18, 32.7%), and Ward 20 (16, 29.1%). Of the fifty-five smallholder farmers, 31 (56.36 %) were female, while 24 (43.64%) were male. The highest education level attained by the respondents was secondary education (26, 47.3%), followed by primary complete (10, 18.2%) and primary

incomplete (11, 20%). Most respondents were aged between 40-55 (27, 49.1%) years, followed by 56-65 (15, 27.3%) and 30-39 (3, 5.5%) years. In Table 4-1 the socioeconomic profile of the smallholder farmers that participated in the survey is presented.

Table 4-1 Socioeconomic profile of the survey sample

Variable	Frequency	Percentage
<i>Gender of respondent</i>		
Male	24	43.64
Female	31	56.36
<i>Status of respondent</i>		
Able-bodied male	23	41.82
Able-bodied female	27	49.09
Living with a chronic illness	3	5.45
Elderly headed household	2	3.64
<i>Age of respondent</i>		
30-39	3	5.45
40-55	27	49.09
56- 65	15	27.27
66 and above	10	18.18
<i>Education level</i>		
Primary incomplete	11	20
Primary complete	10	18.18
Secondary school	26	47.27
High school	3	5.45
Tertiary	5	9.09
<i>Average Household income per month</i>		
500-999	1	1.82
250-499	3	5.45
Less than 249	29	52.73
Not sure	22	40.00

The survey had 52.73 % of the smallholder farmers with incomes less than US\$249 per month. This figure was based on the official exchange rate of 1 Zimbabwean dollar to United States dollars 0.0016 despite parallel market rates as high as ZWD850 to US\$. In Table 4-2, the findings show that in the period before, during, and at the time of the study, crop and livestock farming were the dominant (83.64 %) sources of income for the smallholder farmers.

Table 4-2: Main sources of household income (multiple responses)

Income source	Before programme		During programme		Time of study	
	Frequency	%	Frequency	%	Frequency	%
Farming (crop/livestock)	46	83.64	46	83.64	46	83.64
Remittances	4	7.27	5	9.09	8	14.55
Pension	8	14.55	6	10.91	6	10.91
Wage/Casual labour	8	14.55	7	12.73	7	12.73
Government assistance	1	1.82	0	0	0	0
Income generating activities	10	18.18	9	16.36	8	14.55
Others	1	1.82	1	1.82	0	0

The plan was to have 8 participants at each FGD. There were between 4 to 9 smallholder farmer participants in the FGDs. Table 4-3 summarises attendance to the five FGDs by Ward.

Table 4-3: Summary of FGD coverage by ward

FGD No	Ward Name	Meeting point	Date of FGD	Duration	Participants		
					Male	Female	Total
1	Ward 10	Povo Business Centre	29/10/22	75 mins	2	2	4
2	Ward 9	Kawondera Primary School	29/10/22	82 mins	7	2	9
3	Ward 20	Trelwaney business centre	31/10/22	85 mins	4	4	8
4	Ward 9	Kawondera Primary School	01/11/22	91 mins	3	2	5
5	Ward 10	Murindagomo business centre	02/11/22	72 mins	0	7	7
Total					16	17	33

In Ward 9, the first FGD meeting had four (4) participants in attendance, while the second had 100 % of the target. In Ward 10, the attendance rate for the first meeting was 50 % (4) of the target, while the second meeting had 88 % (7). In Ward 20, attendance to the first FGD was 100 %, while the second was cancelled. Though the plan was to have an equal (50 %) representation of females and males in the FGDs, this could not be achieved as the former had a slightly higher (52 %) representation than the latter. The reasons for nonattendance by smallholder farmers that had expressed availability for the FGDs included commitments with funeral and memorial services, the demand for urgent family travel, rains, crop planting and the concurrent distribution of free agriculture inputs. It was considered inappropriate to request the farmers to attend the FGD sessions, unless they did so voluntarily. Efforts to replace farmers by availability were not successful for the same reasons.

The study interviewed eight (8) key informants, of whom 6 were male and 2 females. The key informants included four (4) from ZFU, and two (2) AGRITEX staff, and community-based agents (2). Staff from the risk insurance provider could not be interviewed as those that worked on the CSS programme had left employment and could not be contacted. The interviews targeted only staff that were involved in the implementation of the programme with objective experience, which was not possible in the circumstances. This did not affect the research questions as the study's primary focus was on the demand-side, smallholder farmer, experience.

Most, 80%, of the farmers bought the combo product during the August 2017 to January 2018 period. Only 5.5 % of the farmers bought the product between August to December 2019. Fewer (1.83 %) farmers bought the combo product from August 2019, the period when the programme was in its close-out phase.

4.2.2. Climate change risks experienced by communities

The targeted communities experienced the effects of climate change. The majority, 83.64 % (46) of the smallholder farmers acknowledged that at the time that the CSS programme was launched, climate change was a concern to them. This was confirmed by all 33 FGD participants. Fisher's exact test was used to determine whether there was a significant association between gender and experience with climate change before the start-up of the programme. There was not a statistically significant association between gender and experience with climate change before the programme started ($p = 0.062$). Similarly, Fisher's exact test was used to determine whether there was a significant association between age, education status, and the well-being status of the smallholder farmer and experience with climate change before the programme start-up. The results reveal that there was no statistically significant association between age and education status and experience with climate change before the CSS programme was launched (age $p = 0.826$; and education status $p = 0.068$). The results for the well-being status of the smallholder farmer revealed that there was a statistically significant association between the well-being status of the household head and experience with climate change before the programme start-up ($p = 0.009$).

As Table 4-4 illustrates, the most mentioned climate change-related risks experienced by the farmers was the change in the rainfall pattern (42.74 %), followed by the scarcity of water (13.71 %) and lastly, the loss of grazing land (12.1 %).

Table 4-4: Climate change risks before the launch of the CSS programme

Climate change risk	Frequency	Percentage
Change in rainfall pattern	53	42,74%
Scarcity of water	17	13,71%
Loss of grazing land	15	12,10%
Change in temperature	10	8,06%
Food insecurity & crop failure	9	7,26%
Flooding and land degradation	6	4,84%
Siltation of rivers	6	4,84%
Loss of livestock	4	3,23%
Increase in crop & livestock diseases	4	3,23%

The survey findings on the experience of smallholder farmers with climate change stressors mirrored those from the 5 FGDs. In the FGDs, 15 of the 33 participants shared their knowledge and experience, which was concurred by the other 18 farmers, on the change in the rainfall pattern. The notable changes in the rainfall pattern discussed in the FGDs included both very low and high rainfall, compared to the past. From all five FGDs, there was an overwhelming consensus that their locations were receiving very low rainfall more often than in the past. The Povo, Murindagomo, and Kawondera-2 FGDs had 12 participants that felt they had experienced very high rainfall, with frequent flooding they had not experienced in the past. Also noted were changes in the timing of rains, that no longer fell during the usual October period to either being unpredictable or pushed further towards the end of each year. At the Povo and Kawondera-1 FGDs, smallholder farmers were of the view that rains changed to falling between mid-November and December. The discussions at the Kawondera-2 FGD pointed that the rainfall season used to end in January each year, but this shifted to March and in some instances, June. From three FGDs, the conclusions were that in some seasons, the intensity of the rains had become very light compared to the past, and in others, they fell for short periods, but with hail and flash floods that damaged crops and homesteads. At the Kawondera-1 FGD, the farmers light-heartedly exchanged how they were using signs from the occurrence of cyclones in Mozambique to predict the intensity of rains in their district. From the Povo, Murindagomo, and Kawondera-2 FGDs, farmers exchanged how in the past they predicted the onset of the rainy season, prepared the land, planted crops early, and would have early harvests. Some of the experience of the farmers with climate change repeated the FGDs included:

We had rivers that flowed by end of November and overflowed in December. This changed by 2015, as some did not

In the past the rainy season ended by end of January or early February. This had changed to March. In one year around,

even flow in December. Maybe until we had heavy rains in January. (Trelwaney FGD male participant)

2015, I think in June. (Kawondera-2 FGD male participant)

A common view discussed at all FGDs was that changes to the pattern of the rains could be seen in disruptions to agricultural-based livelihoods, particularly the frequent occurrence of crop failure and poor harvests and related food and income insecurity. The below views of FGD participants emerged from every other discussion:

A bad rainy season opened doors for every other problem. Families did not have adequate meals. We had no surplus harvest to sell and insufficient income to pay for food, education, and clothing expenses. (Kawondera-1 FGD male participant)

Harvests failed and food reserves were depleted unlike in the past. We became more cautious to sell any surplus. But that meant we had less income to buy other food we did not produce. (Murindagomo FGD female participant)

The five FGDs had most participants unanimous on the increase in the outbreak of crop pests and livestock diseases since 2015. The outbreak of crop pests was majorly related to the fall armyworm that damaged crops, further compounding the poor harvests. All the FGDs had farmers lamenting the annual onset of the rainy season as the kick-off of the outbreak of Theileriosis, a tick-borne disease nationally known as “January disease.” From each FGD, at least 3 farmers confirmed losing cattle after the outbreak of the disease. The Kawondera-1 FGD, had all farmers confirming deaths of at least 3 cattle with two sharing that they no longer had any, at the time of the fieldwork. Farmers experienced partial and total loss of cattle from January disease induced deaths:

Until 2009 most farmers had cattle. Maybe 6 or so per family. However, around 2016 more had fewer or no cattle because of January disease. (Kawondera-1 FGD female participant)

Most of farmers here and, in the villages, closed their cattle-pens because their cattle died from January disease. (Trelwaney FGD male participant)

In the survey, 16.36 % of the mentions were that the increase in temperature was one of the climate change-related shocks that smallholder farmers experienced. The same issue was discussed in four of the FGDs and was mentioned as having been observed from between 3 to 5 years before the launch of the programme. FGDs had discussions on how changes in temperature affected productive activities in varying ways:

The summer temperatures were higher than before. In the past, I could do some heavy

In the past when first rains fell in the morning, in late afternoon we ploughed the

work during the day without experiencing excessive heat and exhaustion. Around 2017 the temperature levels were so high that it was difficult to do the same work during much of the day. (Povo FGD female participant)

fields. The years leading to start of the combo we ploughed immediately after the rains otherwise the land would be too hard and difficult to work. (Murindagomo FGD female participant)

Overall, the survey data and the FGD findings reveal that multiple climate-induced stressors had been experienced in the communities by the time the programme was launched.

4.2.3. Household level risks experienced by communities

In Table 4-5, the range of household risks that smallholder farmers experienced before the launch of the CSS programme are presented. The risk most (36.96 %) experienced by smallholder farmers included food insecurity. The unavailability and high input costs had a share of 20,29 % of the mentions, while the lack of access to improved housing, water, sanitation, and hygiene services had 16.67 %.

Table 4-5: Household risks before launch of CSS programme

Household risks	Frequency	Percentage
Food insecurity	51	36,96%
Unavailable and fluctuating costly prices goods and services	28	20,29%
Unimproved housing, water, sanitation, and hygiene services	23	16,67%
Illness in household	11	7,97%
Poor infrastructure	6	4,35%
Poor quality of agriculture inputs	6	4,35%
Livestock diseases and deaths	5	3,62%
Lack of non-farm skills and unemployment	5	3,62%
Insufficient agricultural land grazing and cropping land	3	2,17%

At all FGD sites, the participants were expressive on how before the CSS programme, households no longer harvested enough food to meet their consumption needs. In addition, they discussed of post-harvest crop losses and withholding of harvests because buyers were not offering competitive prices. At four FGDs, the discussions highlighted how food availability had dropped from previously having enough food to last from one harvest to the next, to only about 7 months in a year. In the discussions, 23 of the 26 participants made contributions that could be related to the views expressed below:

Without climate change, we already had food insecurity risks. Most families could not afford to plant the same size of land because they did not have enough money to buy the required but too expensive inputs. We no longer harvested enough to last a full season but sometimes 6 to 8 months. We no longer planted the same size of land as in the past. (Povo FGD female participant)

We were not having enough food to meet our seasonal household food needs. Many resorted to buying food and adjusting number of meals much earlier than we felt the climate change effects. (Murindagomo FGD male participant)

At the 5 FGD 30 of the 33 participants were involved in deliberations on how crop surplus to sell to the market had dropped. Probed on why they needed to sell instead of reserving the food for consumption, the motivation given was for households to access cash for other food and non-food expenses. At four of the FGDs the deliberations had consensus on how households understood how food surplus and food insecurity were entwined with many other household needs. From all the FGDs, the participants discussed how they had to fill the food availability gap through food purchases from the market, engaging in other productive activities to generate income, and in some instances, selling small livestock. Four of the FGD participants spoke of how in 2018, they were going through intense pressure from food insecurity that they participated in different opportunities, in search of practical solutions. Food insecurity insights below are closely similar to repetitions at almost every FGD:

Two years before the combo programme food insecurity had become more widespread. There was not enough food for families. It was common to skip meals and be less selective of what we ate but just filling stomachs. Most could not afford the frequently increasing prices of food commodities. (Kawondera-2 FGD female participant)

We needed to survive. We pushed and explored every possible means to find relief to food insecurity. I was not used to engaging in piecework to get cash or in-kind payments, my family and others had to do that. (Murindagomo FGD male participant)

A female and male participant at Murindagomo and Kawonder-1 FGDs shared experience which was echoed by others in the same and other FGDs on the role of small livestock in addressing food insecurity:

We relied on selling small livestock such as chickens and goats to cover food needs.

Small livestock were a saviour for most families that had dire food shortages. Food

We also used the proceeds to buy agriculture inputs.
(Murindagomo FGD female participant)

commodities were exchanged with small livestock. It was better than buying with cash. (Kawondera-1 FGD male participant)

There were views shared at four of the FGDs on how food insecurity and ill health were related. These are represented in contributions by two female participants:

Food insecurity attracted poor health for all family members but more for children. Families ended-up spending more to solve both food insecurity and illness.
(Kawondera-2 FGD male participant)

Food insecurity and illness slowly moved family members to the grave. Many in our community were on treatment that worked best with access to food. We believe some unfortunate families had members in critical conditions because of irregular access to enough food. (Kawondera-1 FGD female participant)

The participants were probed on whether the household risks were not a repeat of the impact they had associated with climate change stressors. It was the view of two farmers that if the climate change stressors had been mitigated by adopting CSA practices, then food insecurity would not have been a stress. There were 13 participants whose views were divided, as they perceived the situation would still be the same with either climate change stressors or food insecurity. The view of two participants reflected what was discussed at other sites:

Food insecurity was already a serious problem with most families before climate change. Families already struggled to have the usual three meals a day. (Kawondera-1 FGD female participant)

The two were of equal concern and each had its way of stressing households. If climate change concerns were taken out, that would not erase the stress of food insecurity. Since around 2000 we already had food insecurity as our currency lost value while prices increased. (Povo FGD male participant)

The views below had concurrence of other participants at the two FGDs and those from the other FGDs:

We had periods of good harvests but still, with food insecurity. The high cost of everything from food, education, and health meant we sold more but of less useful value. Climate change only elevated

What did climate change have to do with the prices of food products? Even without climate change the prices continued to increase beyond our affordability.
(Trelwaney FGD male participant)

stressors we already had. (Murindagomo FGD female participant)

At all FGDs references were made to farmers who had adopted CSA practices yet still experienced food insecurity risks:

We participated in CSA programmes that promised to address food insecurity. These closed but our situation did not change. We still struggled to put food on the table, pay for school fees and other needs (Murindagomo FGD female participant)

In 2013 we had a programme promoting similar CSA practices. After two years this ended. There was some improvement in food production but not enough to address our pressing household needs. The burden of healthcare, clothing and general well-being remained with us. (Kawondera-1 FGD male participant)

There were 16 other FGD participants who were adamant that household risks were stressors they experienced independent of climate change. They shared similar examples as the others, concerning food shortage, illness of members, and inability to pay for education and clothing expenses, but only differed in that they saw these as independent of climate change stressors. They believed that the performance of the economy and its impact on incomes and prices of goods and services, quality of inputs, shortage of household labour, mismanagement of and unplanned policy changes on currency, had caused these risks.

The five FGDs had participants sharing views on how the quality of inputs was linked to changes in agricultural production and creating risks for farming households. The views for two FGD participants were echoed at other discussions:

Unknown varieties of agriculture inputs found their way on the market. They were cheap so farmers would buy. But the inputs were the cause for farmers not harvesting enough. When farmers had food shortages how could that be a climate change issue? (Kawondera-1 FGD male participant)

We had agriculture input sellers that appeared and disappeared after making their sales. They would have made enough money and moved to other areas. You applied some of the chemicals, but the pests never died. We only realised after toiling that we used cheap and poor-quality inputs. (Povo FGD male participant)

At all FGDs, the discussions highlighted the disruptions experienced from high and unstable inflation, modalities of payment, and delays in the processing of payments after delivering agricultural produce to buyers. All five FGDs had farmers sharing examples of changes that they noted in the prices of specific products. At the Povo FGD, a participant shared how within a month,

each week the same 10-kilogram bag of maize seed or fertilizer had different retail prices. From the Trelwaney and Kawondera-1 FGDs participants shared the risks they experienced, and this resonated with views at the other discussions:

<i>If a farmer procrastinated buying a 50 kg bag of seed in one week the following week, they had two decisions to make. Either finding more money to buy the same bag or buying smaller quantity of seed matching the cash they had. (Trelwaney FGD female participants)</i>	<i>The prices of inputs increased so fast that it was difficult for a farmer to plan. When one envisaged planting a 50 kg bag of seed, by the time they wanted to buy that could only be 30 kgs. (Kawondera-1 FGD male participant)</i>
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There was consensus at all FGDs, that most farmers had difficulty raising additional cash whenever they experienced price fluctuations on goods.

The five FGDs revealed the challenges that farmers experienced while trying to sell their agricultural output. The market prices of crops grown in the three wards were regulated by the government and farmers were required to sell to specific agencies. The two issues discussed at the FGDs were firstly, the mismatch between the crop producer prices set by the agencies and secondly, the late timing of the payments to farmers. It was the experience of the farmers from the 5 FGDs that the producer prices were set at levels that did not allow them to recoup their production costs, to reinvest for the next planting season while meeting other basic household needs. The farmers articulated how their situation was made worse by indefinite and delayed payments by agricultural output buyers, including those that were controlled by the government. The Kawondera-1, Kawondera-2 and Murindagomo FGDs had different views expressed highlighting how attempting to get payments from output buyers only worsened the situation, as the decisions were never prompt, the delays meant prices of inputs continued to increase and they incurred additional costs in following-up on the payments. The views of two participants represent what commonly featured at all other FGDs:

<i>We were excited by the promise of buyers paying us on time and in US dollars. In anticipation, we delivered our harvests. Unfortunately, each time the payments were not on time. The US dollars were never received. They gave us an option to buy goods of equivalent value on an</i>	<i>We got paid for our deliveries several months after. Comparing the value of the payment against what we invested killed the spirit of being a farmer. (Murindagomo FGD female participant)</i>
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exchange rate they determined.

(Kawondera-2 FGD male participant)

The loss of cattle to Theileriosis disease was a problem that some farmers from all FGDs did not necessarily associate with climate change. The disease affects cattle at the peak of the rainy season between December and January. Probed on whether this was not associated with climate change, some believed that this was caused by poor access to animal health extension services. A male and female participant from Trelwaney and Kawondera-2 FGDs respectively had this to say:

I have a different opinion; January disease is caused by failure to manage ticks. In the past, dip tanks had good supply of chemicals, and cattle did not die. Without chemicals ticks multiply and kill our cattle. I ask how is that a climate change issue?

(Trelwaney FGD Male participant)

Our veterinary extension had staff but no resources to do their work to control ticks.

We could find it easy to blame climate change, but without chemicals and vaccines cattle still died. (Kawondera-2

FGD female participant)

The FGD, had five other participants agreeing, and similar sentiments were reflected in contributions by 16 participants at three other FGDs. The general view at all FGDs was that the lack of proper knowledge on the management of ticks led to the loss of livestock to January disease. The discussions at the five FGDs revealed how the loss of cattle to disease compounded agriculture production and livelihoods. The views below from two participants represent similar others that came-up at the same and other FGDs:

After the death of cattle, most relied on paying for tillage services. Those with cattle were overwhelmed and prioritized their needs. This led to delays in our land preparation which in some seasons reduced our harvest. (Kawondera-2 FGD

female participant)

Most farmers that paid for tillage service could not afford. They reduced the size of land they used to till. That of course also came with reduction in the harvests.

(Trelwaney FGD male participant)

A commonly shared view at all FGDs was that access to draught power had a share effect on food security and incomes. Two farmers contributing to discussions and supported by other participants shared views commonly raised in other four sessions:

When I had cattle, I harvested not less than 5 tonnes of maize. Since I lost my cattle and paid for tillage services, the harvests were between 2 and 3 tonnes. I had less

Since most farmers reduced the size of land they planted, their harvest and incomes fell making them more food

*food for the family and could not sell surplus to meet other needs.
(Povo FGD male participant)*

insecure (Murindagomo FGD female participant)

The five FGDs had housing and water, sanitation, and hygiene-related issues discussed as risks that affected the community. Two participants shared labour and health related experience that were discussed at all sites:

*We were forced to use unsafe or distant water points. This made us less productive and competing to access water points
(Povo FGD male participant)*

As public sanitation facilities were not functional, open defecation was more practiced. We had diarrhoea outbreaks that we were not used to. (Trelwaney FGD male participant)

In addition to multiple climate change related stressors, smallholder farmers equally experienced complex household risks including others that were perceived to have independent risks.

4.2.4. Discussion

In Zimbabwe, 52 % of the population comprise women and they are the majority, 70%, of the agricultural labour force (Food Agriculture Organization, 2017; Zimbabwe National Statistics Agency, 2022). Women have a predominant representation among smallholder farmers in the country, and they have higher than men exposure to the effects of climate change (Food Agriculture Organization, 2017; Huyer & Partey, 2020; Khatri-Chhetri *et al.*, 2022). Women dominate the sector, despite the persistence of inequities in accessing productive resources including land, financial services and exclusion from decision-making processes, social norms, and access to inputs, information, and extension services (Mashizha, 2019; Huyer & Partey, 2020; UNWomen, 2022). Though women had 56.36 % representation in the survey the national outreach of the CSS programme had slightly more men (51 %) than women (49 %), which mirrored the Zvimba District-level gender ratio (ZIMSTAT, 2022). Mutenje *et al.* (2019) concluded that fewer women than men participate in CSA programmes, despite their dominance in the agricultural sector. The same reasons behind the inequities facing women in the agricultural sector influence their level of participation in CSA programmes (Huyer & Partey, 2020). The gender ratio in the CSS programme outreach can be attributed to the design of the programme that did not demonstrate a deliberate approach to enhance gender equality. A more deliberate approach to increase the participation of women was required, given the importance of the agricultural sector as a source of employment, income, and food security for their households, as noted by UNWomen (2022).

A notable finding from the study is the low participation of youths in the programme, confirming their general low participation in agricultural activities (Madende *et al.*, 2023). The barriers to youth participation in agriculture include lack of access to productive resources such as land, financial services, equipment and infrastructure, skills and adverse opinions. Maisule *et al.* (2023) argue that the attributes of youths, such as energy, mental prowess, persistence, and inventiveness, give them the edge to be productive and contribute to agricultural production, yet they have low participation in the sector. Considering observations from other studies, it may be plausible to conclude that age may influence the adoption of some CSA practices, but not all (Nyengere *et al.*, 2016; Zampaligre & Fychs, 2019). The representation of older farmers in the sample is at variance with conclusions from other studies where they were perceived to resist adaptation and prefer to stick to familiar farming practices (Nyengere *et al.*, 2016; Negera *et al.*, 2022). The findings by O'Shea *et al.* (2018) led to the conclusion that old age not only influences conservativeness but negatively affects innovation. In this study, the higher representation of older smallholder farmers demonstrated their desire to adapt. This points to the likelihood that besides the age of the smallholder farmers, there could be other drivers of risk perception and decision to participate in CSA programmes that transcend age.

The study sample had a broad representation of education profiles of the smallholder farmers from the lowest primary incomplete to tertiary level. The findings do not necessarily align with conclusions reached in other studies. A study by Kassa and Abdi (2022) in Ethiopia concluded that education had a positive influence on the adoption of adaptation measures, given the capability it gave farmers to make “educated” decisions. Similar conclusions on the influence of the education profile of the farmer on adoption decision-making were made from other studies in Pakistan by Sardar *et al.* (2021) and in Malawi by Nyengere *et al.* (2016). In a study of smallholder farmers in Kenya, a distinction was between formal and non-formal education, with the latter influencing tendencies for higher adoption of CSA practices than the former (Okumu *et al.*, 2023). In formal education, which aligns with the current study, the primary school adopters had significantly higher adoption tendencies than both secondary and tertiary levels. Given the spread in the education profile of the sampled farmers in Zvimba District, the significance of the education level to participation in the CSS programme is not apparent.

Most of farmers were in the lower-income band. This is despite the programme requiring farmers to pay for the combo product. It can be concluded that the pricing of the combo product was not a barrier to adoption, as this was affordable by the target groups. This is important, given that the income level of households has often been regarded as influencing the adoption of CSA practices.

In a study of farmers in Nigeria, one factor that influenced the adoption of CSA practices was the income level (Sardar *et al.*, 2021; Oluwakemi *et al.*, 2022). Lower income was found to be a barrier to adoption, as farmers could not afford the costs associated with the technology.

The study findings confirmed a conclusion by FAO on the dominance of farming as a source of income for rural households in Zimbabwe (FAO, 2017). Similar findings were made among farmers in Nepal by Mishra *et al.* (2020). Another resemblance between the current study and that in Nepal and other contexts was that farming households depended on multiple sources of income at any given time (Jambo *et al.*, 2019; Mishra *et al.*, 2020). As found from the FGDs in Zvimba District and from Tanzania and Malawi by Jambo *et al.* (2019), farmers engaged in multiple economic activities to smoothen their cash flow, mitigate risks, as coping strategies, and take risky investment decisions. O'Shea *et al.* (2018) concluded that off-farm income sources provided an enabling environment for exploration and innovation from the skills that those involved acquired. The finding from the study in Zvimba District affirms an argument by Jerneck and Olsson (2014), that regular episodes of food insecurity drive smallholder farmers to pursue alternative income-generating opportunities. A phenomenon found during the study was that of saving in small livestock, particularly goats and chickens. Households liquidated them for cash to meet other needs such as food, education and healthcare expenses.

The study affirmed that smallholder farmers not only had knowledge of climate change but experienced its effects before the launch of the CSS programme. The smallholder farmers demonstrated their knowledge of what climate change was by identifying key changes they had observed and experienced. The basis for the observed changes were patterns that the smallholder farmers perceived to have experienced before the advent of climate change. The changes that smallholder farmers experienced included low intensity of rainfall, late start and end of the rainy season, late start in the flow of rivers, drying up of water points, high day temperatures, outbreak of crop and livestock diseases, increasing incidences of crop failure and reduction in grazing pasture. The finding on the experience of the farmers with the shift in the rainfall pattern concurs with similar observations made by Mashizha (2019) in a study of 40 farmers in the same Zvimba District. The findings by Mashizha (2019) also revealed an overall shift in the seasonal calendar, with the final agricultural activity, processing, happening from June to August under climate change effects, as compared to May to July in the past. Smallholder farmers discussed their experience with the loss of crop harvests and livestock because of climate-induced stressors. These findings are pertinent, given the views on the influence of awareness and experience with climate change on risk perception and adaptation decision-making by smallholder farmers. In the

Model of Private Proactive Adaptation to Climate Change (MPPACC), experience with climate change is considered a driver in shaping risk perception and adoption decision-making by farmers. A study in Ethiopia made two conclusions on the possible adoption responses by farmers, depending on whether they had an awareness of climate change or had been impacted by climate change (Negera *et al.*, 2022).

Few studies have paid particular attention to the presence and significance of household risks as stressors that stimulate risk perception, while seeking to understand the situation of smallholder farmers in the context of climate change. Like climate stressors, the study established that before the CSS programme was launched farmers experienced multiple and complex household risks they regarded as risks. Cavanagh *et al.* (2017) cautioned on the risk of non-adoption, lack of sustainability, and negative impacts of CSA practices when the needs of smallholder farmers, particularly the poorest, are not understood and factored in policies and programmes. This followed findings from a study in Kenya, where an agro-forestry project had farmers distinctly questioning the rationale of planting trees when they were not already planting enough maize to meet their consumption needs. In some instances, farmers were selling tree seedlings for cash to spend on other needs. Cavanagh *et al.* (2017) revealed the atypical household well-being factors as concerns and risks to farmers that if not addressed, could influence adoption behaviours. Regarding food insecurity, Jerneck and Olsson (2014) labelled this as a “food imperative”, for smallholder farmer households. In describing “the food imperative,” Jerneck and Olsson (2014) paint it as a state where households experience both physical and mental pressure from their anxiety over food insecurity. This is a state that could apply when households have health, water and sanitation, and education risks. As the current study revealed, there were household risks that imposed significant pressure and risk to farmers, in addition to the effects of climate change. The household risks included food insecurity, illness of household members, poor access to health care services, unaffordable education expenses, fluctuation in prices of goods and services, and lack of drinking water. The smallholder farmers also experienced outbreaks of livestock diseases and deaths, insufficient grazing land, and low productivity of livestock. In crop production, the challenges included the unavailability and prohibitive costs of agriculture inputs, lack of access to output markets, low crop producer prices, post-harvest crop losses, outbreak of crop pests and diseases, and lack of farm implements. Though there were several household risks that had low mentions in the survey, it was clear from the articulation of the smallholder farmers that they were alert to how these were interlinked and compounded effects on their livelihoods. These were core to the viability of agriculture-based livelihood systems for the smallholder farmers. As an example, limited access to inputs and price fluctuations affected the production planning and capacity of smallholder farmers as they were forced to reduce the scale

of crop production. In all FGD sessions, the farmers were in harmony that both limited access to inputs and price fluctuation often forced them to buy whatever types and packaging of agricultural inputs that could fit the cash they had. In most cases, these were poor quality and small quantities of inputs which forced some to reduce the areas under planting. This consequently reduced crop harvests, contributing to challenges of food availability and self-sufficiency that farmers had at the time the programme was launched.

The loss of livestock especially cattle was of significance to food insecurity. Cattle were a major source of draught power during land preparation, crop planting and weeding, harvesting, and transporting produce to output markets. The farmers whose cattle died had to rely on paying for tillage services from those with cattle or tractors. The high demand for tillage services meant that some farmers experienced delays in the timely preparation of cropping land. In some instances, the smallholder farmers resorted to the use of paid human labour for land preparation and weeding, which added to their production costs. Paying for mechanised services and human labour added production costs for already income-constrained farmers, resulting in reduced size of land prepared for cropping, quantities of inputs they could afford, and the timeliness for production activities. The fall in production increased the risk perception of farmers.

The study validates the occurrence of multiple climate change stressors and concurrent presence of complex household risks all with consequential effects on crop and livestock production, food security and general inability to meet household needs. In seeking to understand the climate change stressors and household risks experienced before the launch of the CSS programme, the study aligned with observations on the interconnectedness of stressors or risk drivers made by Connolly-Boutin and Smit (2016). They note that climate change should be viewed as one stressor interconnected with others such as food insecurity, livelihood insecurity and poverty. The complexity of the risk context of smallholder farmers must not only be acknowledged but purposely responded to by deliberate risk focused engagements. The purpose of the engagements will be to allow smallholder farmers to profile their risk environment. They must be empowered to identify and prioritise the risks and their consequences. Doing so will ensure programmes are directed to the risk prevention and mitigation measures that are shaped by the priorities of smallholder farmers.

4.3. Assessing the influence of household risks on farmer decision-making in the adoption of the combo product in Zvimba District

In this section, the objective is to examine how the risk context of smallholder farmers influenced the adoption of the combo product. The study concurs with the MPPCA that risk underlies the

decision-making process of farmers seeking to adopt CSA practices (Grothmann & Patt 2005). In the majority, climate change-induced risks have been observed as the drivers of farmer decision-making when adopting adaptation measures (Ahmed *et al.*, 2021; Musafiri *et al.*, 2022; Reddy *et al.*, 2022). In Section 4.1, the findings of the study revealed that beyond the climate-induced risks, farmers had household risks that some preferred not to associate with climate change. Whether the household risks were associated with the adoption of CSA practices is the focus of this section. In the observations of Elrick-barr *et al.* (2015) and Cavanagh *et al.* (2017), households have risks, regarded as survival imperatives such as food insecurity, illness, household expenses and emergencies. There is limited literature that covers the role of survival imperatives as drivers of risk in the adoption of CSA practices. Of the available literature, Elrick-barr *et al.* (2015), Cavanagh *et al.* (2017) and Fayso (2018) provide compelling arguments for attention to be paid to better understand these survival imperatives. When survival imperatives are present, they potentially contribute to influencing farmers in their decision to adopt and continue practising adaptation measures. The understanding of the breadth of the survival imperatives and their influence on smallholder farmer decision-making provides evidence for use in the adapted design of CSA programmes. Elrick-Barr *et al.* (2015) recommend integrating household survival imperatives when designing responses to climate hazards. Knowledge on the survival imperatives may aid in better explaining and addressing some of the challenges with the low adoption of CSA practices (Hailu *et al.*, 2014; Phuong *et al.*, 2018; Sibiko *et al.*, 2018).

4.3.1. Influence of climate change risks on adaptation

The study sought to validate the predominant view that climate change stressors drive risk perception and adaptation decision-making (Ahmed *et al.*, 2021; Reddy *et al.*, 2022; Zhou *et al.*, 2022). This was achieved by asking smallholder farmers whether the climate change stressors they had experienced influenced their decision to adopt the combo product. A 'Yes' or 'No' response was required, and the results indicate that the majority (89.1%) of the smallholder farmers believe that their experience with climate change stressors influenced their decisions to adopt the combo product. On the other hand, only 10.9% of the farmers answered "No", meaning that the climate change stressors had not influenced their decisions to adopt the combo product. The Fisher's Exact test was used to determine whether there was a significant association between the demographic characteristics of the survey sample and views on the influence of climate change stressors on the decision to adopt the combo product. As results in Table 4-6 show, there was not a statistically significant association among any of the demographic characteristics, and the views on the influence of climate change stressors on the decision to adopt the combo product.

Table 4-6: Fischer's Exact Test on the influence of climate change risks on the decision to adopt the combo product

	p=	value
Gender		0.686
Age		0.209
Education status		0.740
Well-being status of household head		0.541

In the FGDs, there were mixed sentiments on the influence of climate change stressors in the adoption of the combo product. From the five FGDs, 19 out of the 33 farmers agreed that climate change stressors influenced their decision to adopt the combo product. In the matrix to assess consensus in the FGDs, the 19 agreed with verbal contributions, from which 10 provided significant statements and examples to support their decision. There were more (13) women than men (6) FGD participants who agreed on the influence of climate change stressors on their decision to adopt the combo product. Notable across the five FGDs was how the farmers established an association between the stressors and the onset of low agricultural performance, which in turn directly negatively affected their livelihoods. The smallholder farmers were expressive that the adoption of the combo product was an indication of their desire to contain and prevent further impacts of the stressors on their main sources of livelihood.

Though most participants in the FGDs had consensus that climate change influenced the decision to adopt the combo product, there were some dissenting voices. Some participants did not see a link between the climate change stressors and their decision to adopt the combo. Of the FGD participants, fourteen (14) did not agree that climate change stressors influenced their decision to adopt the combo product. There were more men (9) than women (5) who did not agree that climate change stressors influenced their decision to adopt the combo product. The contributions that concluded that climate change had not influenced their decision to adopt the combo product included 10 verbal expressions, with 4 providing significant supporting statements or examples. In the FGDs, there were compelling views from some participants across gender, acknowledging the presence and impact of the climate change stressors, but not viewing these as the drivers for their decision to adopt the combo product.

It is concluded that in general, the effects of climate change stressors influenced the adoption process of the combo product, regardless of the gender, age, education, and income status of the smallholder farmer.

4.3.2. Influence of household level risks on adaptation

In line with observations by other authors the study focused on understanding whether the less prominently featured household risks had influenced the decision of farmers to adopt the combo product (Elrick-barr *et al.*, 2015; Cavanagh *et al.*, 2017; Fayso, 2018). The study ascertained that household risks had influenced the farmers in Zvimba District to adopt the combo product. In the survey, the majority (81.8 %) of the respondents agreed that the risks influenced their decision to adopt the combo product, 5.5 % strongly agreed, 9.1 % disagreed, and 1.8 % both strongly disagreed, neither agreed nor disagreed. Three (2 male and 1 female) smallholder farmers in the FGDs believed it was by coincidence that the CSS programme was launched at a time when they experienced household social and economic risks. They were adamant that the household risks were the prime drivers for their adoption of the combo product. A view expressed by one male participant from the Povo business centre summed up the perception of the farmers during the FGDs:

We adopted the combo because of risks we had after failing to meet our household needs such as paying for education and food. These could be traced to economic collapse, the uncontrollable increase in prices of goods and services, and the low prices that were paid on our crop produce. The climate change issues were by coincidence additions to the risks that we already had but not the main issue. We could have joined any other programme if it showed that it would change our well-being.

The household risks spanned multiple areas that included food insecurity, illness, unaffordable costs for education, input and labour costs, poor access to input and output markets, unemployment, poor shelter, water and sanitation services, and livestock diseases and losses. The risks that influenced the decisions of farmers to adopt the combo product are presented in Table 4-7. Food insecurity had the most share (37.21 %) of mentions for having influenced the adoption of the combo product. This was followed by a lack of non-farm skills and unemployment (17.05 %), and unavailability and costly goods and services (13.18 %). The analysis of FGDs using Venn diagrams did not show any variation by gender in the representation of views. Male and female farmers similarly shared views on the role of household risks in the adoption of the combo product.

Table 4-7: Household risks that influenced the adoption of the combo product

Risk	Frequency	Percentage
Food insecurity	48	37.21%
Lack of non-farm skills and unemployment	22	17.05%
Unavailable and costly goods and services	17	13.18%
Illness in household	11	8.53%
Lack of access to agricultural inputs	8	6.20%
Livestock diseases and deaths	7	5.43%
Poor infrastructure	7	5.43%
Unimproved housing, water, sanitation, and hygiene services	5	3.88%
Insufficient agricultural land grazing and cropping land	4	3.10%

The survey findings align with those from the FGDs, where there was overwhelming consensus that household risks were risk drivers that influenced the decision to adopt the combo product. The varied views exchanged included the perceived social and psychological pressures and desperation imposed on households because of inability to provide for basic needs. In the five FGDs, food insecurity was the most discussed household problem for the risk it created on the well-being of households. There are 15 household risks commonly discussed in all FGD sessions and, food insecurity had a larger share (10 %) of the 990 contributions. The matrix of consensus analysis showed that from the five FGDs, 29 of the 33 participants made contributions on how households experienced prolonged and dire periods of food insecurity that forced them to participate in any programme opportunities, driven by the desire to change their circumstances. From all the five FGDs, the adjustment of meals, selling of assets, and engaging in piecework in local villages by households were brought up in discussions on forced coping mechanisms in response to food insecurity. A female participant from Trelwaney FGD shared her views on the forced sale of assets:

Some in our community had severe shortages of food so they were forced to sell some of their valuable assets such as cattle and goats. Unfortunately, they were forced to sell their possessions which affected their ability to negotiate for fair prices. When one knew the children at home are hungry, they ended up taking up any offers made.

The five FGDs discussed varying examples of assets that were sold to address urgent food needs that included goats, chickens, and roofing sheets. A participant from Kawondera-1 FGD had this to say about their experience with disposing of household assets.

Unfortunately, the possessions were being sold at a time when most people in the community had strained incomes. There were no or very few local buyers so we depended on those coming outside our district. Some came for a limited time or were just passing through our village, and we knew once they left, we would have lost the chance to sell and save our families. So, we would be forced to sell to the most immediate opportunity.

At the Trelwaney FGD, a female participant was emphatic and supported by five others in her view that the pinnacle of parental failure was not providing for the food and education needs of children. When these needs are not provided the common local perception was that the parents lacked capability and care and were failures. Most participants at the five FGDs were apprehensive about reaching this level as they perceived this as a weakening of their self-esteem. The lack of parental capability was viewed within the context of how the local community valued the responsibility of parents to provide their children with access to adequate basics such as clothing, food and education. Figure 4-1 shows the Venn diagram analysis of how in the five FGDs, nine women and one man were the first to contribute views on how food insecurity and high education expenses were risks that influenced their decision to adopt the combo product. Further, the Venn diagram shows that the participants from all FGDs, including men and women, contributed to discussions on food insecurity and high education expenses.

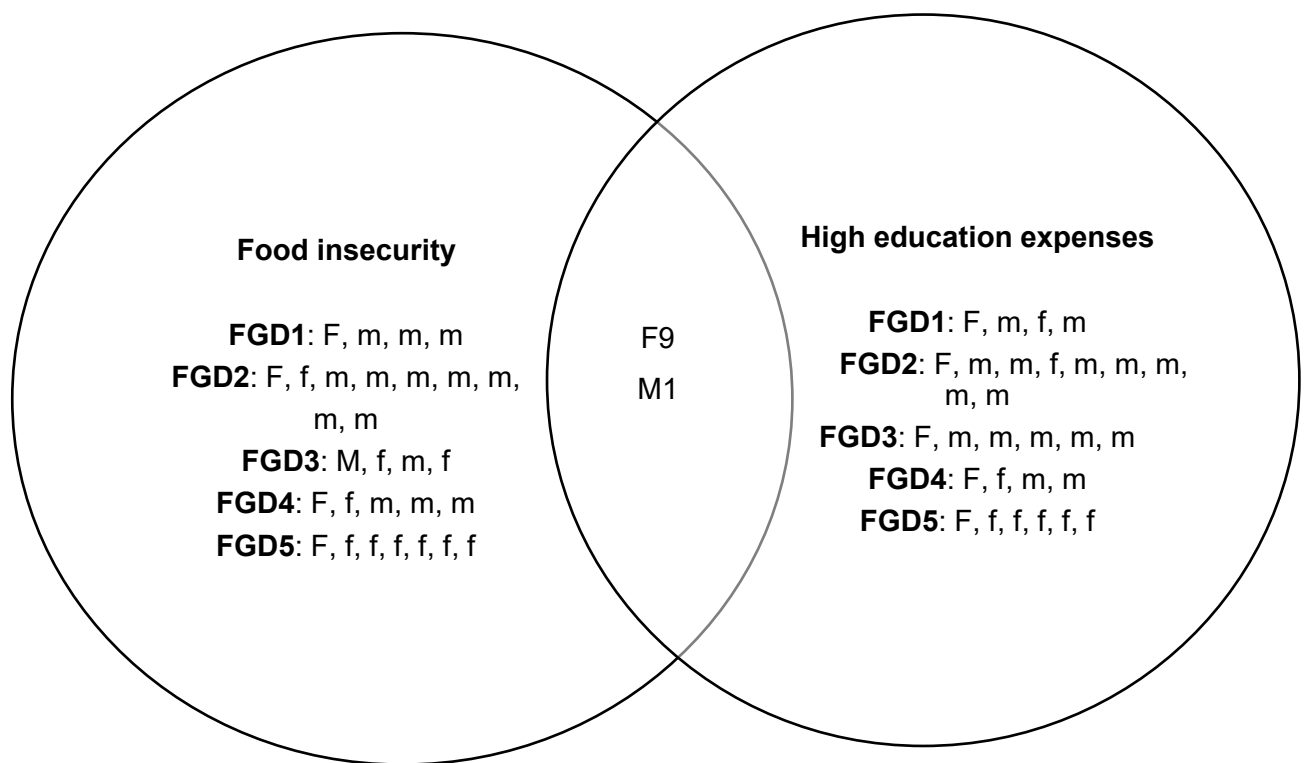


Figure 4-1: FGD responses on food insecurity and high education expenses by gender

The matrix to analyse consensus at the Povo and Trelwaney FGDs, shows that men (6) and women (6) had balanced views on how household risks caused fears and pressure for loss self-esteem and parental responsibility. However, women tended to express more emotive views on how parental image was affected when children were not provided with their food and education needs. In the view of one female participant at Murindagomo FGD, this was because women had the most responsibility in ensuring children accessed food and attended school. A female FGD participant from Kawondera-2 FGD summed up perceptions variously shared in the FGDs:

If you did not do anything about providing your children with their needs for food, education, and clothing then as a parent you would have failed and will become the talk of the village.

The Povo and Kawondera-2 FGDs, had 8 of the 13 participants expressing worries about children asking questions in instances when they lacked basics such as food, clothing and education. This was perceived as a source of shame for parents. A female participant at the Povo FGD expressed

how this risk consequence forced parents to participate in programmes launched in their community:

As parents, we had to try everything possible to give our children something meaningful to be at school and well-fed, but it was not easy as most of us could not afford it. Again, you would think if you did not sacrifice to educate the children then you were not giving them a future. This both scared you and motivated you to join programmes that were introduced in the community, as happened with the combo programme.

All FGDs had both men and women discussing their experiences with risks related to funerals, clothing and agricultural inputs. There was a near-balanced representation of gender in the first contributors to questions, as shown in the Venn diagram in Figure 4-2. There were 8 men and 7 women who were the first contributors to different questions posed to the groups.

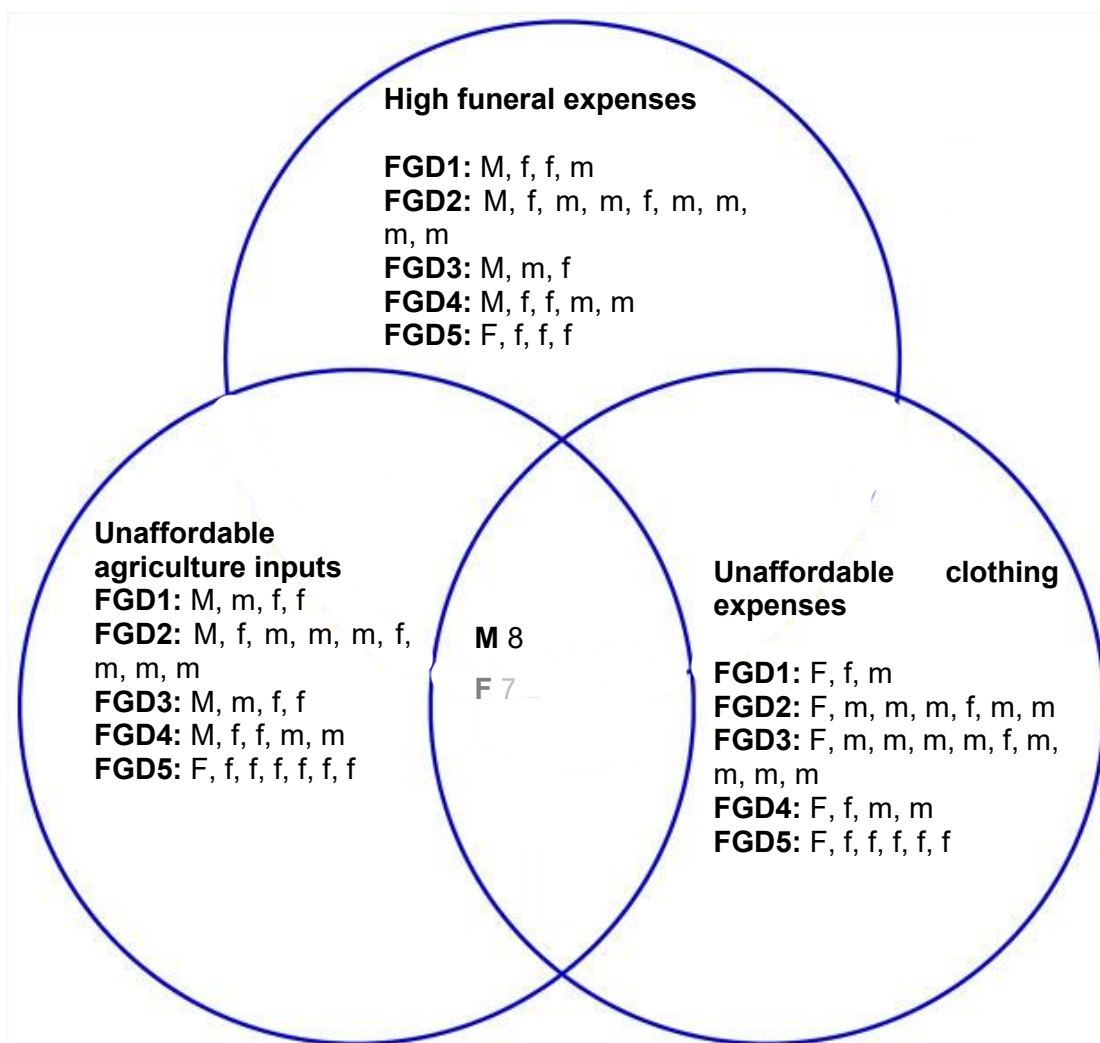


Figure 4-2: FGD responses on unaffordable agriculture inputs and clothing expenses by gender

The discussions highlighted that before the launch of the CSS programme, the costs for funerals had risen, yet communities still had high expectations for affected families to have the resource capacity to cover the required expenses. At four FGDs, the discussions revealed how the prohibitive costs created the risk of not giving decent burials to family members. It was the view of a participant at Povo FGD that other community members were only expected to provide labour and moral support as they were financially strained. A view expressed by a participant at Murindagomo FGD represented those from the other three FGDs:

Burying our relatives was very costly for most families and a source of shame for those who could not afford it. The families that were not struggling either had funeral policies or had relatives working abroad that afforded sending remittances in times of need.

The farmers discussed how, during the launch of the CSS programme, they were informed that the combo product included a funeral cover. The service was viewed as a motivation for adopting the combo product, given the responsibilities that the community expected of families. The funeral cover was seen as a service providing relief to families while allowing them to conform to community expectations.

In the FGDs, farmers discussed how the problem of access to quality and affordable agriculture inputs had peaked by the time the CSS programme was launched. The dominant view from the five FGDs was that this was driven in two ways and the main factor being inflation. First, farmers at all FGDs believed their risks started with the frequent changes in the local currency-denominated prices of agricultural inputs while retail outlets only accepted United States dollar-only transactions. At the Kawondera-2 FGD, a male participant explained that it was common to have local currency prices being reviewed weekly, which participants agreed was confusing, making it difficult to plan and afford the inputs. Further, at Trelwaney FGD, a female participant explained how retail shops set prices in the local currency yet only accepted payments in United States dollars. She explained how difficult it was to get the United States dollars, partly because of the scarcity of the currency in the rural areas, and their low local currency incomes that did not allow them to buy enough foreign currency when requiring to transact. There were 25 out of the 33 FGD participants who responded, agreeing to the problem created by changes in prices of goods and services and currency used in transacting, as shown in the analysis in Figure 4-3.

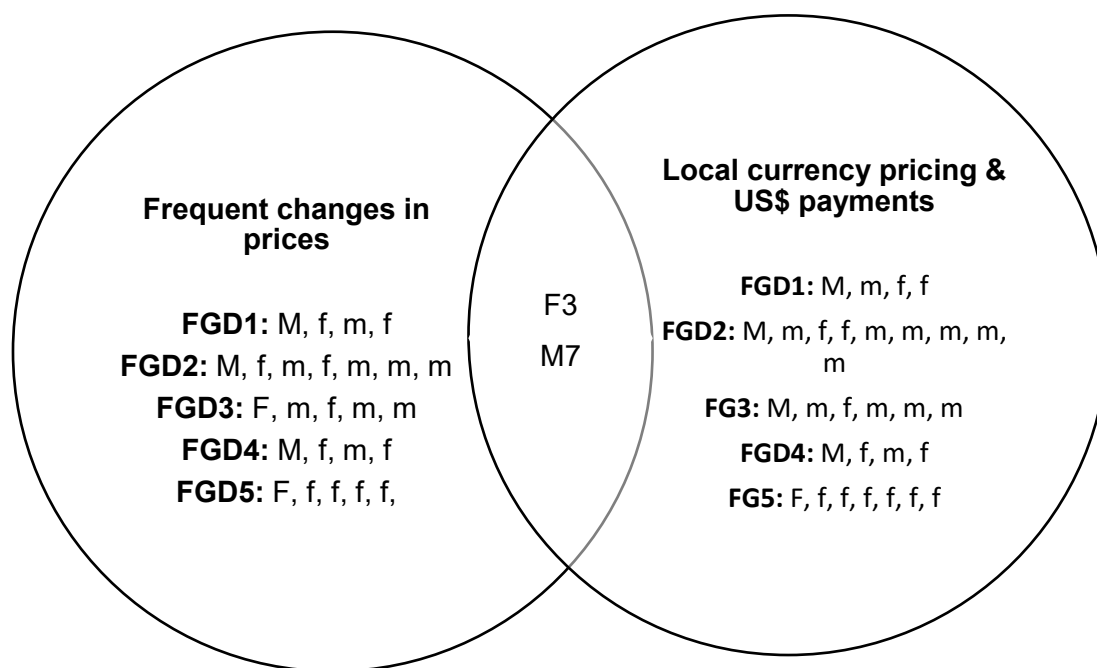


Figure 4-3: FGD responses on frequent changes in prices and local currency pricing & US\$ payments by gender

Second, the farmers exchanged on the challenges arising from the disparity of being paid in the local Zimbabwe currency for their agricultural produce, despite paying for production inputs in United States dollars. The Kawondera-1 FGD had a female participant explaining how in 2019, the payment she received after selling her maize harvest was less than a quarter of the United States dollars that she spent on agricultural inputs. In all FGDs, the discussions repeatedly highlighted how the collapse in the macroeconomic environment had increased prices of inputs to levels that pushed the farmers to reduce the usage of quality agricultural inputs and the size of land that they tilled. From Kawondera-2 FGD, one male participant, with the verbal concurrence of two female farmers, referred to arable land that smallholder farmers in the community had let fallow because they could not afford enough agricultural inputs. There were 29 of the 33 FGD participants who agreed on the challenges created by the disparity between the currency they invested in, and that in which they received payments after selling their agricultural produce. The sentiments of the farmers highlighted how the situation was compounded by the government setting exchange rates that were far below market rates and the actual pricing of goods and services. Generally, the discussion points of the 29 participants were in unison that what they were paid was not enough to allow them to reinvest in agricultural production and meet their day-to-day basic needs. The farmers perceived that the problem of the high cost of inputs intensified their food and nutrition insecurity. In the circumstances, the desire to maximise the use of the

arable land was viewed as the driver to participate in programme opportunities that appeared to address challenges related to access to inputs.

An argument repeated by farmers at all the FGD sites was that agriculture was their main source of livelihoods and when production was affected, they would not have enough harvest to cover food needs and surplus to sell for income. The farmers concurred that when the CSS programme was being promoted, it appeared as an opportunity to restore and address their risks with access to agricultural inputs, and this was an important motivation for participation. A view shared by one female FGD participant from Kawondera-2 mirrored contributions from others in the same session and other four FGDs:

In the community mobilization meetings for the combo programme, they mentioned that we would have better access to inputs that would improve our harvests. As farmers whenever a conversation includes agriculture inputs, we do not ask a lot of questions and are motivated to participate.

Participants from four of the FGDs were of the view that it had become normal for farmers to participate in programmes without paying much attention to the design but just anticipating that in some way they could find an immediate impact on household risks. A participant from the Povo FDG stated:

We needed our households to overcome the multitude of risks we faced including food insecurity, access to healthcare, and paying for education expenses. So, when new programmes were launched, most of our expectations were that somehow, they would bring change to our circumstances.

In the survey, a Likert scale was used to allow farmers to rate the extent of their agreement with household risks having influenced their decision to adopt the combo product. The majority (81.82 %) of smallholder farmers agreed that household risks influenced their decision to adopt the combo product, as shown in Table 4-8.

Table 4-8: Household risks influenced the decision to adopt the combo product

Statement	Disagree	Neither Agree nor Disagree	Agree
Household risks influenced your decision to adopt the combo product	10.91	1.82 %	87.27 %

The results from the one-sample Wilcoxon signed rank test showed that the respondents agreed that household risks influenced their decisions to adopt the combo product [$n=55$, $Mdn=4$, $Z=5.408$, $P < 0.0001$]. The Fisher's Exact test was used to determine whether there was a significant association between demographic characteristics of the survey sample and views on the influence of household risks on the decision to adopt the combo product. There was not a statistically significant association between any of the demographic characteristics and the views on the influence of household risks on the decision to adopt the combo product, as illustrated in Table 4-9.

Table 4-9: Fischer's Exact Test on the influence of household risks on the adoption of the combo product

	p=value
Gender	0.218
Age	0.233
Education status	0.821
Well-being status of household head	0.431

A common thread repeated at all FGDs was that when participating in programmes, farmers expected inclusion of tangible receivables that they could use to directly and immediately impact the well-being of their households. The matrix of consensus showed a balanced representation in the views of men and women during discussions on the expectations of households from programmes. In the FGDs 25 participants agreed, out of which 13 provided significant examples of how local communities had expectations for tangible benefits. A female participant from Povo FGD added her supporting views to the discussion:

There have been many programmes using similar information service-based approaches in agriculture, health, and sanitation. Yet we still had our well-being circumstances unchanged. Most people attended the first meetings because we expected there were going to be some tangible benefits. After the first project

meetings, it was clear it was the same approach, and few people attended. We want programmes to be giving us tools to apply the information and change our lives.

The discussions at the five FGDs referred to a then-two-year-old government-supported agricultural input distribution programme for farmers practising conservation agriculture, popularly known as *Pfumvudza*. Farmers who participated in the programme received a package of maize seed and top and bottom dressing fertilizers. At three FGDs, smallholder farmers argued that even though the inputs distributed were not enough, at least they were tangible benefits and that directly addressed the problem of high cost of agricultural inputs. At the Povo, Murindagomo, and Kawondera-1 FGDs, seven participants had a consensus that farmers practicing *Pfumvudza* recorded high maize harvests in the past two seasons. Smallholder farmers emotively discussed how they had high expectations that the CSS programme would directly address their most pressing household risks as done by the government programme. There was one dissenting female voice from Trelwaney FGD, that viewed the *Pfumvudza* programme as benefitting only a few that were partisan to local leaders.

A female participant at Kawondera-1 FGD used experience from a faith-related incident to emphasise how community members were expectant of practical benefits to motivate their participation in programmes:

I invited fellow villagers to attend a local church service. One of them was very upfront in asking me whether going to the service would help her with a bar of soap.

The expectations of tangible improvement in the life of farmers are what motivates them to participate in programmes.

Participants from four FGDs believed that when immediate needs were met, farmers are motivated to continue practising adaptation measures and more would adopt. At Kawondera-2 FGD, participants used the example of how more farmers continued to annually want to enrol on the *Pfumvudza* programme because of the tangible inputs. At three FGD sites, while farmers acknowledged the importance of climate-related information and meetings, they felt that there was a limit to their tolerance of such approaches. The limit to tolerance was when the same approaches are repeated while there was persistence in the failure of the programmes to address household risks. During the Kawondera-2 FGD, a female participant constantly referred to how the ZFU had a long list of farmers that had initially shown interest to participate in the CSS programme. She argued, with the concurrence of two male participants, that most farmers on the list had put on-hold participating in the programme because they wanted to see how early joiners would benefit. After about six months, very few of the farmers participated because the programme did not offer tangible changes to their livelihoods. Participants were in unison that the

lack of tangible benefits was a major factor in the lack of new adopters, drop-outs, and continued use of the combo product.

The combo product offered farmers a bundle of eight (8) services listed in Table 4-10. Smallholder farmers were asked whether they would have bought the combo product, if each of the services had not been included. This informed whether the motivation for adaptation was driven by the package or individual services.

Table 4-10: Likelihood of buying combo product without individual services

Variables	Frequency (%)
Would buy combo product without livestock promotion	21 (38.2 %)
Would buy combo product without drought-tolerant varieties	19 (34.5 %)
Would buy combo product without Maize WII	14 (25.5 %)
Would buy combo product without maize & livestock information	13 (23.6 %)
Would buy combo product without input discounts	13 (23.6 %)
Would buy combo product without ZFU membership	12 (21.8 %)
Would buy combo product without weather information	8 (14.5 %)

Across the eight services, there was a considerable number of smallholder farmers who would not have bought the combo, had any of the services not been included. The service that would have influenced most (85.5 %) farmers not to adopt the combo product, was weather information service, followed by ZFU membership (78.2 %). Livestock promotion had the least (61.8 %) share of farmers that would not have adopted the combo product if the service had been excluded.

The smallholder farmers used the 5-point Likert scale to measure the likelihood of buying the combo product if the individual services had been excluded. The data in

Table 4-11 is presented as percentages of the total number of study participants. A summative analysis shows that most (60.68 %) ratings of the preferences were that farmers were unlikely and extremely unlikely to buy the combo product, had the services not been included. Most (69.09 %) of the smallholder farmers rated that they were unlikely and extremely unlikely to adopt the combo product, had the weather information not been included. The same proportion of farmers rated that they were unlikely to adopt the combo product without the maize weather index insurance. About 58.18 % were likely and extremely likely to adopt the combo product without the funeral cover.

Table 4-11: Rating the likelihood of buying the combo product without some services

Rate the likelihood of buying combo product without:								
	Funeral cover	ZFU membership	Input discount	Drought-tolerant varieties	Livestock promotion	Weather information	Maize & livestock information	Maize WII
Extremely likely	3 (5,45 %)	1 (1,82%)	0,00%	2 (3,64 %)	1 (1,82 %)	1 (1,82 %)	1 (1,82 %)	1 (1,82 %)
Likely	29 (52,73 %)	16 (29,09%)	13 (23,64 %)	14 (25,45 %)	20 (36,36 %)	14 (25,45 %)	13 (23,64%)	10 (18,18 %)
Neutral	2 (3,64 %)	4 (7,27%)	7 (12,73 %)	4 (7,27 %)	5 (9,09 %)	2 (3,64 %)	4 (7,27%)	6 (10,91 %)
Unlikely	21 (38,18 %)	33 (60 %)	31 (56,36 %)	33 (60 %)	27 (49,09 %)	36 (65,45 %)	37 (67,27 %)	38 (69,09 %)
Extremely unlikely		1 (1,82%)	4 (7,27 %)	2 (3,64 %)	2 (3,64 %)	2 (3,64 %)		

The Fisher's Exact test was used to determine whether there was a significant association between age, gender, education status, and the well-being status of the household head and the rating on the likelihood to buy the combo product, had individual services been excluded in the combo product. The results in Table 4-12 show no statistically significant association between most demographic characteristics and the rating on the likelihood of buying the combo product, had some services been excluded. However, the results reveal that there was a statistically significant association between age and the rating on the likelihood of adopting the combo product if livestock promotion had been excluded ($p = 0.006$). Similarly, the results revealed that there was a statistically significant association between the education status and the rating on the likelihood of adopting the combo product if livestock promotion had been excluded ($p = 0.004$).

Table 4-12: Fischer's Exact Test on rating the likelihood of buying the combo without some services

Service	P value			
	Gender	Age	Education status	Well-being status of household head
Funeral cover	0.462	0.309	0.832	0.451
ZFU membership	0.757	0.859	0.053	0.622
Input discount	0.532	0.333	0.660	0.622
Drought-tolerant varieties	0.244	0.329	0.273	0.319
Livestock promotion	0.395	0.006	0.004	0.655
Weather information	0.059	0.089	0.054	0.066
Maize & livestock information	0.511	0.546	0.095	0.607
Maize WII	0.951	0.064	0.200	0.923

The findings reveal that most smallholder farmers were unlikely to adopt the combo product, had most of the eight services been excluded. This indicates that each service had a contribution in influencing the decision to adopt the combo product. Smallholder farmers preferred a package of services. The survey findings were affirmed in the FGDs, with the matrix of consensus showing that all FGDs had 30 out of 33 participants concurring on the importance of all the services included in the combo, despite concerns over lack of access to some of them.

4.3.3. Discussion

Climate change stressors influenced smallholder farmers to adopt the combo product. The observation affirms experience from several other contexts, where similar climate change stressors had been experienced such as Bangladesh, India and Kenya by Ahmed *et al.* (2021); Musafiri *et al.* (2022) & Reddy *et al.* (2022). In these countries, the climate change-related stressors experienced include dry spells, extreme rainfall and flooding, heat stress, drought, the outbreak of crop pests and animal diseases, extreme temperatures, and a decrease in rainfall. The study did not observe a significant association between gender, age, educational levels, and type of income sources of the smallholder farmers and the experience they had with climate change stressors. In addition, the study did not find demographic characteristics influencing the decision to adopt the combo product. This however cannot be taken as a basis to dispute or challenge findings that have been made in other contexts where the same demographic factors influenced adaptation decision-making. Studies by Musafiri *et al.* (2022), Zakari *et al.* (2019) & Nnodim & Raji (2020), found age, gender, experience, income, and education levels influencing the adoption of different types of adaptation measures by farmers. In a study of smallholder farmers in Malawi, among others gender, marital status, education, and wealth status were found to influence decision-making in the adoption of adaptation measures (Khoza *et al.*, 2019). Other authors found factors such as age, income status, education status, experience and gender of household head determining adaptation (Musafiri *et al.*, 2022; Zakari *et al.*, 2019; Nnodim & Raji 2020). The inability of the current study to determine the presence of a significant association between age, level of education, and adoption of CSA practices is not unique, given the findings from other contexts where the same factors inconsistently determined the adoption of CSA practices (Nyengere *et al.*, 2016; Akroush *et al.*, 2017; Pronti *et al.*, 2019; Zakari *et al.*, 2019; Musafiri *et al.*, 2022; Negera 2022; Ogisi & Begho 2023). For example, a study in Jordan found age not influencing the adoption of water harvesting technologies, while in Italy, age influenced the adoption of water conservation and saving technologies (Akroush *et al.*, 2017; Pronti *et al.*, 2019). It will be pertinent to question why the same farmer characteristic would determine different decision outcomes to the stressors similarly induced by climate change. Such variations could be pointing to the likelihood that aside of the demographic factors there may be other factors such as the psychological, social and economic that also influence different decision outcomes. A revelation from the study is the presence of multiple household risks that were perceived to have overwhelming and urgent risk consequences that smallholder farmers were grappling with in addition to those driven by climate change risks. The intensity and complexity and concurrent occurrence of climate and household risks and their risk consequences could diminish the significance of some demographic factors in adaptation decision-making. Limited prevention and

mitigation options could imply all demographic profiles are equally affected. Regardless of their demographic profile smallholder farmers shared similar observations on how their communities were affected by climate change stressors, and how this subsequently influenced their decisions to adopt the combo product. There is merit for further research to explore the factors that influence the disparity in adoption decision outcomes when there is similarity of demographic characteristics of the farmers and particularly in multiple risk contexts.

Despite the demographic characteristics not influencing the decision to adopt the combo product they were associated with the views of smallholder farmers on certain issues. Education status had a statistically significant association with views on the likelihood of adopting the combo product, if drought-tolerant input varieties had not been offered. Similarly, a statistically significant association was found between education status and views on the likelihood of adopting the combo product, if maize and livestock information tips had not been included. In the instances education may improve chances of influencing better appreciation of the value of the services to the livelihoods of smallholder farmer households. The well-being status of the household head had statistically significant association with views on the likelihood of adopting the combo product if maize and weather index insurance had not been offered.

Household risks were stressors with risk consequences that influenced a considerable number of the farmers to adopt the combo product. The household risks and their risk consequences have similarities with observations in other countries such as Australia, Kenya and Ethiopia (Elrick-barr *et al.*, 2015; Cavanagh *et al.*, 2017; Fayso, 2018). In these countries some of the household risks included food insecurity, access to water, illness and access to healthcare, ability to pay for household expenses, and unemployment. In this study, the same risks were observed, and additions include unaffordable education expenses, outbreak of animal diseases, lack of access to input and output markets, death of livestock, lack of farm implements and capital. Household risks are associated with negative risk consequences that include a deterioration in the well-being of household members, death, loss of assets, loss of self-esteem, and negative community labelling. An observation to be made from the study is that beyond climate change risks smallholder farmers concurrently experienced other social and economic risks that influenced their vulnerability. These social and economic risks were associated with having own direct influence on the decision of the smallholder farmers to adopt the CSA practices, partly independent of climate change.

The inadequacy of approaches that focus on a single risk is made by Kipato *et al.* (2023). This could partly explain the low uptake and lack of sustainable adoption of CSA practices observed in several contexts (Peterson, 2014; Sibiko *et al.*, 2018; Strauss *et al.*, 2021). The study puts to the fore the concurrent multiplicity and complexity of risk drivers that smallholder farmers grapple with at any given point. Climate related stressors and household risks appear to share a complex intensification of the same risk consequences, though even so there may be other several risk drivers farmers encounter. In the study even with the two risk drivers smallholder farmers were less clear and perceived both climate change and household risks to have influenced the same adaptation decision outcome. This confirms similar observations by Duong *et al.* (2019), Komarek *et al.* (2020), Osiemo *et al.* (2021) & Kipato *et al.* (2023). Separating and attributing the share or weight of the risks may be difficult but an area that could be subjected to further research. What can be drawn for programme design purposes and as argued by Cavanagh *et al.* (2017), is that household risks must be purposely targeted and integrated in CSA programmes to reduce elements that could be disincentives to adaptation decision-making. Leaving the household risks to be addressed as indirect outcomes of successful implementation of technical CSA practices appear to fall short of the expectations of smallholder farmers for more direct and immediate impact.

The psychological outcomes of smallholder farmers are influenced by a plethora of factors. The study points to the significance of risks whose consequences have psychological implications on smallholder farmers. The feelings and perceptions of parental failure, deviation from community norms and loss of self-esteem can be associated with psychological outcomes. The Framework for the determinants of mental health and well-being by Lawerance *et al.* (2022) outlines multiple interrelated drivers to mental health and well-being outcomes. These include socio-economic and political conditions, living and working conditions, social and community networks, individual psychology and lifestyle factors and demographic and personal traits (Lawerance *et al.*, 2022). Each of these can generate psychological conditions that include emotional responses, social influences and cognitive biases to events or situations that can positively or negatively shape adaptation choices. In the study living and working conditions, social and community networks, individual psychology and lifestyle factors and demographic and personal traits variously influence how smallholder farmers decided to participate in the CSA programme. Inability to provide food, education and health needs and general well-being of family members were perceived to trigger risk consequences that included feelings of parental failure, deviation from community norms and loss of self-esteem. The pressure to participate in CSA and other programmes launched in the communities was perceived to be driven by expectations for practical means to prevent or mitigate the emotional and social risk consequences. Smallholder farmers

were of the view that they were less likely to participate in programmes that did not practically address the underlying drivers of these consequences.

The study points to the likely misalignment between the perceptions of smallholder farmers on their motivation to participate in programmes and the purpose of programmes and how this could drive sustainability and scale in the adoption of adaptation measures. Household problems pressure smallholder farmers to be opportunistic participants not driven by the purpose of programmes. Participation in programmes is regarded as an alternative hustling effort to address the survival imperatives of smallholder farmers. During and post programme implementation the motivation to adopt and continue using adaptation measures is seen in the ability to directly impact both short and medium-term practical needs of households in addition to climate change-related stressors. When survival imperatives are not directly addressed, and they persist as risks to households programmes focusing on a single risk are perceived as inappropriate. When the practical needs of smallholder farmers are not met this creates risks of dropouts and wait-and-see attitude by potential adopters and unfavourable programme outcomes. Pragmatic questions emerging from the findings relate to who and how to prioritize risks in contexts of multiplicity and complexity. The views of smallholder farmers are that decisions on the scope of programmes decided by designers and therefore miss their priority risk drivers. If given a chance the perception of smallholder farmers is that household problems are equal if not more important and preferred that these are directly addressed by programmes. In the view of the Smallholder farmers highlighted the need to balance between information-based CSA interventions and those that directly impact their practical needs. Combining strategies that respond to both climate hazards and household social and economic risks align with the argument by Elrick-Barr *et al.* (2015).

The adoption of the combo was unlikely if any of the individual services had been excluded. Smallholder farmers view the blending of services increasing the scope and chances for multiple needs being directly addressed. Services that smallholders preferred added to the combo with likely positive impact on sustainability and scale of adoption include access to loans, medical insurance, consumption support, improved customer support and information sharing, as well as locally accessible service points. The smallholder farmers preferred these services as they perceived them to partly contribute to the objectives of CSA practices, while additionally assuring them of access to healthcare services, accumulating assets, diversifying income sources, and building social capital. In addition, there was strong preference for programmes to include mechanisms that assured sustainability of access to services. Smallholder farmers were unlikely to continue using some services such as funeral cover, ZFU membership and livestock promotion.

This lack of motivation to continue using the services is attributed to lack of experience and limited information on the services during the period of programme implementation. Smallholder farmers had difficulties determining the worthiness of a service they had not used.

The findings highlight the imperative for co-creation of programmes with the participation of smallholder farmers as part of the stakeholder groups. The co-creation should entail engagement of smallholder farmers to better understand their circumstances and how they perceive the significant elements and actions. The risk elements combine those experienced at individual farmer level and those applicable at group and community level. The knowledge of what applies and is significant at the different levels can only be determined through engagement with the farmers. Further the co-creation engagements should include empowering smallholder farmers to identify existing and new knowledge, actions and services that they believe best address their priority risks.

4.4. Determining the scope of household risks impacted by the combo product among smallholder farmers in Zvimba district

This section presents the findings of the study on the scope of household risks that were impacted by the combo product among the smallholder farmer adopters. The focus was on the household risks that farmers had at the time that the CSS programme was launched. The purpose was achieved by asking farmers to identify which of the household risks they had before the CSS programme had been impacted by the combo product. The findings would also reveal whether the interventions directly or indirectly impacted the household risks.

4.4.1. Utilization of the combo product

In determining the scope of impact of the combo product, analysis focused the combo product broadly and the individual combo services, as farmers had the discretion to use all, or some of the services. The range of services comprising the combo product and their utilisation by smallholder farmers is shown in Table 4-13. The frequency of responses received is expressed as a percentage of the total number of respondents. The service with the most (83.6%) utilisation is weather information service, followed by drought-tolerant varieties (80 %), and maize and

livestock information tips (67.3 %). For other services in the combo, the results show very low utilisation ranging from 1.8 % (1) to 16.4 % (9) of the survey sample.

Table 4-13: Utilization of the combo services

Service	Frequency (%)
Weather information service	46 (83.6 %)
Drought-tolerant varieties	44 (80 %)
Maize and livestock information tips	37 (67.3 %)
ZFU membership card	9 (16.4%)
Input discounts	9 (16.4%)
Livestock promotion service	4 (7.3%)
Funeral cover	3 (5.5%)
Maize WII	1 (1.8%)

The Fisher's Exact test was used to determine whether there was a significant association among age, gender, education status, and the well-being status of the household head, and the use of the combo product. The results shown in Table 4-14 indicate that there was not a statistically significant association among most of the demographic variables, and the use of the combo product. However, the results reveal that there is a statistically significant association between education status and the use of the funeral cover ($p=0.011$).

Table 4-14: Fischer's Exact Test on the use of the combo product

Service	P = value			
	Gender	Age	Education status	Well-being status of household head
Funeral cover	1.000	1.000	0.011	1.000
ZFU membership	0.157	0.184	0.442	0.653
Input discount	0.482	1.000	0.691	0.878
Drought-tolerant varieties	0.738	0.435	0.224	0.311
Livestock promotion	0.307	0.051	0.127	0.542
Weather information	0.482		0.660	
Maize & livestock information	1.000	0.936	0.418	0.571
Maize WII	0.436	0.236	1.000	0.091

The survey findings are mirrored by discussions in the FGDs, where in general there was low utilisation of most services. From the 5 FGDs, there were four (4) out of the 8 services in the combo product, that were most used: the drought-tolerant varieties, livestock promotion, weather information, and maize and livestock information. As the summary of the FGD matrix for assessing consensus in

Table 4-15 shows, the drought-tolerant varieties had most (31) FGD participants indicating that they had used the service and 10 shared significant examples. In every FGD, all participants made contributions that included raising points and concurring with responses. There were no points of dissension on the use of drought-tolerant varieties.

Table 4-15: Summary of FGD participants and services used

FGD	Funeral cover	ZFU membership card	Input discounts	Drought-tolerant varieties	Livestock promotion	Weather information	Maize & livestock information	Maize WII
Povo	0	0	0	4	3	4	4	0
Kawondera 1	0	0	1	8	8	8	8	0
Trelwaney	0	0	0	8	7	7	7	0
Kawondera 2	2	2	0	4	4	4	3	2
Murindagomo	0	0	0	7	6	6	7	0
Total	2	2	1	31	28	29	29	2

Analysis of the level of consensus on the use of services in the combo product showed that women FGD participants made more (53,17%) agreeing contributions than men (46,83%). The matrix of assessing consensus showed that there was a close balance in men (15) and women (16) participants who agreed that they used drought-tolerant varieties. Even though farmers paid for the drought-tolerant inputs, the practical application of the information and direct and indirect relevance of outcomes to household risks were given as the drivers to utilisation. The related views from 12 FGD participants were that promoting drought-tolerant varieties was apt motivation to their desire to increase food production, and food availability, even in difficult climate conditions.

The five FGDs had 29 out of 33 participants confirming having used weather information service. In the discussions, the participants exchanged views on how the need for better planning of farming activities was a motivation to use the service. The planning areas that commonly featured in the discussions included knowing when to plough, plant, when and which inputs to apply, weed-cropped areas and harvesting, the release or not of livestock, and anticipation of livestock diseases. From three FGDs, additional discussion points by a mix of 12 male and 14 female participants were on the perceived value of weather information service in improving farmer decision-making about which land preparation methods to use, such as zero tillage or animal-drawn plough and the timing of crop harvesting, depending on the projected weather pattern. At Murindagomo and Kawondera-1 FGDs, the participants perceived the additional value of using weather information services in aiding household members to undertake other tasks such as travel and types of clothes to prepare for school children, depending on the weather predicted for the period. As Figure 4-4 shows, in 8 instances, female FGD participants were the first respondents in three of the perceived motivations for using weather information services.

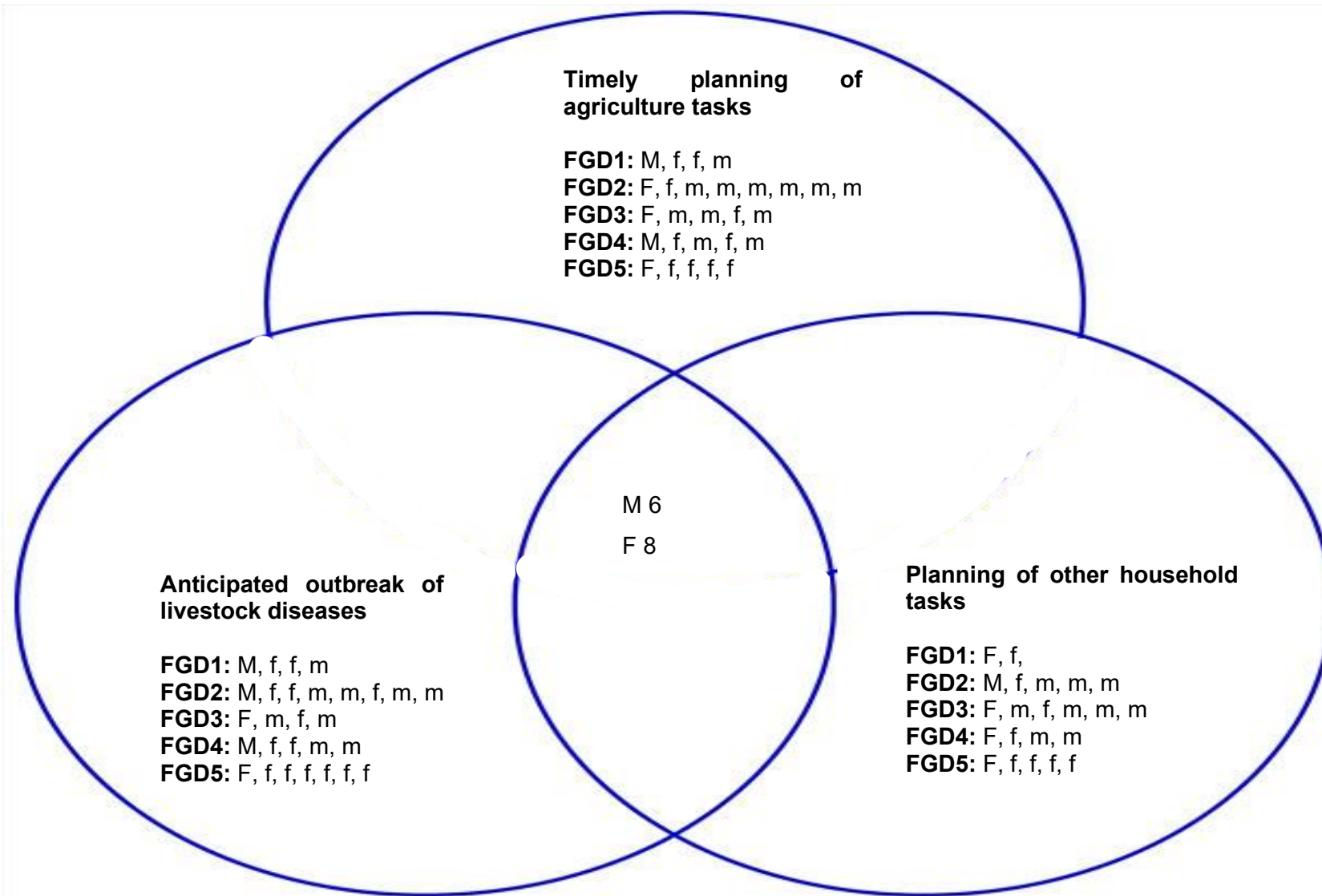


Figure 4-4: Use of weather information services

The combo product included the provision of maize and livestock production information tips to the farmers. The maize information tips included varieties of seeds, planting times and methods, weed and pest management, harvesting, and storage practices. Livestock information tips included animal health information and management, feeding practices, management of reproduction, safekeeping, and record keeping. The five FGDs had 29 out of 33 participants that used maize and livestock information tips. There were 22 participants who made significant contributions to why they used the information tips. The other 11 FGD participants were repeating, concurring, or not having anything to add to the discussion points.

4.4.2. Household level risks impacted by the combo

The study determined the scope of household risks that were impacted by the combo product. Table 4-16 presents the results of the survey on the types of household risks that the combo product impacted. The household risks were reduced into categories and the frequency of their occurrence is indicated in percentage. According to the data, out of the 11 household risks only 2 had been relatively highly impacted by the combo product. The household challenge where the combo product impacted most is food insecurity, with a 48.35% share of the responses. This is followed by unavailability and fluctuating costly prices of goods and services, at 18,68 %. The combo product had minimal impact on the other types of household risks that participants had before the CSS programme, as they had a very low representation ranging from 1 (1.1 %) to 7 (7.7 %).

Table 4-16: Types of household risks impacted by the combo product

Risk	Frequency	%
Food insecurity	44	48,35%
Unavailable and fluctuating costly prices of goods and services	17	18,68%
Livestock diseases and deaths	7	7,69%
Lack of non-farm skills and unemployment	7	7,69%
Low crop producer prices	5	5,49%
Illness in the household	3	3,30%
Lack of capital	2	2,20%
Insufficient agricultural land grazing and cropping land	2	2,20%
Outbreak of crop pests and diseases	2	2,20%
Lack of drinking water	1	1,10%
Poor access to extension services	1	1,10%

The Fisher's Exact test was used to determine whether there was a significant association among age, gender, education status, and views on whether the combo product impacted types of household risks. The results reported in Table 4-17 show that there was not a statistically significant association among gender, age, and well-being status of household heads, and views on types of household risks impacted by the combo product. However, the results reveal that there was a statistically significant association between education status and the views on types of household risks impacted by the combo product ($p = 0.003$).

Table 4-17: Fischer's Exact Test on types of household risks impacted by the combo product

	P=value
Gender	0.299
Age	0.169
Education status	0.003
Well-being status of household head	0.843

The data in Figure 4-5 represent how respondents agreed or not on the impact of the combo product on household risks. According to the results most, 69.1 %, of the respondents agreed that their household risks were impacted by the combo product. However, there is a fair, 29.1 %, representation of respondents that disagreed with the statement. Only 1.8 % of the respondents did not know, indicating that they had limited exposure to the combo product, or did not have enough information to form an opinion.

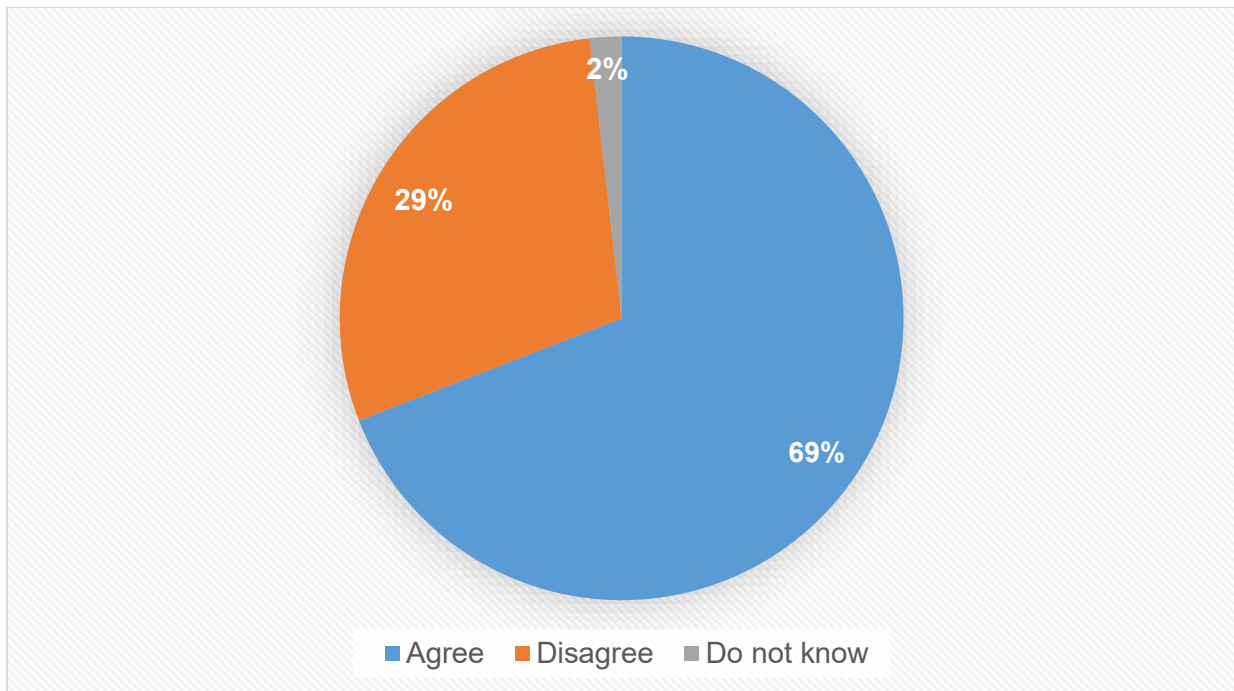


Figure 4-5: Household risks impacted by the combo product

In the FGDs, there was generally very limited acknowledgment that household risks had been impacted by the combo product. The FGDs had 14 of 33 participants agreeing that household risks had been impacted by the combo product. The FGD participants were selective of the services in the combo product which they felt had impacted their household risks. In most cases, this aligned with whether the service had been used or not. They also tended to consider whether the impact was direct or indirect. The data in

Table 4-18 presents the evaluation by the farmers on their satisfaction with how household risks were impacted by the combo services. Overall, the results indicate that the respondents were satisfied with the services, and most falling in the "satisfied" and "very satisfied" categories. The use of drought-tolerant varieties had the highest satisfaction level, with 35 respondents (63.6%) indicating that they were satisfied and very satisfied. On the other hand, the service with the lowest satisfaction level was ZFU membership, with 25 respondents (45.45%) indicating that they were slightly dissatisfied, dissatisfied and very dissatisfied.

Table 4-18: Satisfaction with services in the combo product

Combo service	Very Satisfied	Satisfied	Slightly satisfied	Neutral	Slightly Dissatisfied	Dissatisfied	Very dissatisfied
ZFU membership	2 (3.6 %)	15 (27.3 %)	4 (7.3 %)	8 (14.5 %)	1 (1.8 %)	18 (32.7 %)	6 (10.9 %)
Input discount	1 (1.8 %)	18 (32.7 %)	1 (1.8 %)	13 (23.6 %)	6 (10.9 %)	12 (21.8 %)	4 (7.3 %)
Drought-tolerant varieties	2 (3.6 %)	33 (60 %)	6 (10.9 %)	12 (21.8 %)	0	12(21.8%)	2(3.6%)
Livestock promotion	1 (1.8 %)	12 (21.8 %)	0	23 (41.8 %)	1 (1.8 %)	12 (21.8 %)	6 (10.9 %)
Funeral cover	1 (1.8 %)	9 (16.4 %)	1 (1.8 %)	30 (54.5 %)	2 (3.6 %)	10 (18.2 %)	2 (3.6 %)
Weather information	7 (12.7 %)	32 (58.2 %)	6 (10.9 %)	9 (16.4 %)	0	0	1 (1.8 %)
Maize & Livestock information	3 (5.5 %)	29 (52.7 %)	4 (7.3 %)	15 (27.3 %)	0	3 (5.5 %)	1 (1.8 %)
Maize WII	1 (1.8 %)	30 (54.5 %)	5 (9.1 %)	18 (32.7 %)	0	0	1 (1.8 %)

The Fisher's Exact test was used to determine whether there was a significant association between the demographic variables and the ratings on the level of satisfaction with the use of the combo services. The results in Table 4-19 show that there was not a statistically significant association between some of the demographic variables, and the ratings on satisfaction with the use of most of the services in the combo product. However, the results reveal that there was a statistically significant association between gender and the ratings on the level of satisfaction with the use of the funeral cover ($p = 0.037$). Similarly, the results also reveal that there was a statistically significant association between the education status and the ratings on the level of satisfaction with the use of funeral cover ($p=0.014$), drought-tolerant varieties ($p=0.000$) and weather information (0.044).

Table 4-19: Fischer's Exact Test on rating the level of satisfaction with the combo services

Service	P value			
	Gender	Age	Education status	Well-being status of household head
Funeral cover	0.037	0.337	0.014	0.516
ZFU membership	0.648	0.520	0.461	0.859
Input discount	0.218	0.980	0.429	0.268
Drought-tolerant varieties	0.387	0.212	0.000	0.714
Livestock promotion	0.110	0.476	0.516	0.194
Weather information	0.263	0.173	0.044	0.218
Maize & livestock information	0.088	0.636	0.126	0.420
Maize WII	0.716	0.217	0.270	0.938

In the FGDs, food insecurity was the most mentioned household challenge that had been impacted by the combo product. From the five FGDs, the use of drought-tolerant varieties and livestock and maize information tips was associated with increasing food availability and income within households. The tips were observed to have also generally contributed to changing how households spend on food purchases. The views referenced below commonly featured in discussions:

The information tips helped a lot in overcoming food insecurity. Harvests were mostly enough to cover the annual consumption needs of families. We had fewer

Accurate and timely use of information tips had most farmers increasing the volume of crop production and the survival and quality of their livestock. We significantly managed

months of food shortages, than before the combo. If we struggled, it was just for a month or two, unlike five or six months in the past. (Kawondera-1 FGD male participant)

the food needs of families, even when we needed to buy. (Povo FGD female participant)

Since the combo, we bought less food as we produced enough to consume. When we depended on buying food at times we did not have enough money. We bought and ate less. The information tips helped increase food productivity. (Trelwaney FGD female participant)

The knowledge we applied on crops and livestock changed our lives. We produced much more food than in the past. We needed not to buy food. But we could afford if needed. (Murindagomo FGD female participant)

Similar observations had a mix of 26 men and women having consensus on the impact.

Drought-tolerant input varieties were promoted to increase productivity in the context of moisture-stressed conditions. The programme created awareness on the advantages, requirements for land preparation, planting, and crop management for improved varieties of maize, groundnuts, round-nuts, sunflower and sorghum. Farmers were not provided with inputs but were expected to buy from local agro dealer shops using their own resources. Table 4-20 displays the survey results on the areas of impact that farmers attributed to the use of drought-tolerant varieties. The frequency of each answer is expressed as a percentage of the total number of responses.

Table 4-20: Impact of drought-tolerant varieties on household risks

Types of impact	Frequency (%)
Increased food security	50 (42 %)
Increased yields	27 (22.7 %)
Increased crop incomes	9 (7.6 %)
Reduced use of water	9 (7.6 %)
Reduced use of labour	8(6.7 %)
Increased livestock fodder	8 (6.7 %)
Multi-cropping in a single season	5 (4.2 %)
Planted larger pieces of land	2 (1.7 %)
Other	1 (0.8 %)

Of the 11 household risks drought-tolerant varieties directly impacted food insecurity on three interrelated areas. Drought-tolerant input varieties had most (42 %) impact on increased food

security, followed by increased crop yields (22.7 %) and increased crop incomes (7.6 %). Increased crop yields improve food availability and increased crop income improve ability to access food through market purchases, both of which are elements of food security. At all FGDs participants appreciated how despite reduced and erratic rains good harvests were sustained by drought-tolerant input varieties. At Trelwaney FGD, a male participant shared experience with drought-tolerant maize varieties, that surprised him and other local farmers:

In 2018 around mid-November after two days of the first rains I immediately planted my short-season maize seed. Unfortunately, there were no follow-on rains for four weeks. It became very hot causing crops to wilt. I wrote-off the crop and abandoned it with the belief that it had failed. Follow-on rains fell later than expected. I did not go back to inspect my crop and focused on planting new crop on other pieces of land. I met fellow farmers who asked about the crop that I had abandoned. They were keen to know what I had done for it to be healthy. I became curious and went to check. I was surprised by how healthy the crop looked. No other crop in that part of the farming lands was comparable. We immediately weeded the field, and this further improved the maturity of the crop. We had very good early green mealies and the final harvest was better than fields planted after the second rains.

The participant's story was corroborated by two other FGD participants residing in the same village. In the matrix assessing consensus, the 5 FGDs had eleven other participants who shared different significant experiences on how harvests increased because of drought-tolerant input varieties compared to when they used varieties that were not drought-tolerant. At the Murindagomo and Povo FGDs, the contributions of eight participants pointed to how drought-tolerant varieties assured harvests that provided enough grain for families to consume until the next harvest, where in the past they would not last part of the season. The views of participants at two FGDs resonate with discussions at other sites:

I planted drought-tolerant varieties from 2017. Since then, we had three not-so-good rainy seasons, but harvests have not been bad. My household had enough food to consume and even sell. Yes, what I sold may not have been as much as when we had normal rains. In past droughts harvests were not enough to last a season. (Kawondera-2 FGD male participant)

Our harvests have improved food availability and incomes because we used drought-tolerant varieties. They perform quite well even when we have harsh weather conditions. (Murindagomo FGD female participant)

At Murindagomo FGD, a female participant shared how in the past they did not pay attention to the input varieties they planted. They used to write-off crops during periods of moisture stress. This was confirmed by four (4) other participants from the same FGD and the other four FGDs. At Povo FGD, a male participant shared how the practice of “*kusundira*” had become common after crops failed when farmers did not use improved input varieties during periods of erratic and low rains. Under normal circumstances the practice is reserved for the period after all farmers have completed harvesting mature crops in their fields. Cattle are then allowed on the fields to graze any crop residue. A female participant from Murindagomo FGD described how this practice was experienced:

In our villages, cattle are allowed to graze freely after harvesting maize, usually after June. However, in instances of poor rains and crop failure out of disappointment and loss of hope farmers surrendered to free grazing as early as February or March. We had more instances of such practices three or so years before the combo programme.

At Trelwaney, Kawondera-1 and Kawondera-2 FGDs, the discussions among participants revealed the occurrence of similar practices in their communities.

Table 4-21 presents the results of the survey on types of household risks that were impacted by maize and livestock information tips. The results are presented as the frequency (in percentage) of mentions. Similar to drought-tolerant input varieties the household challenge experienced before the launch of the CSS programme that was impacted by maize and livestock information tips is food insecurity, with 25.14 % on food security. Another area impacted related to food security is high crop yields and incomes. In addition, two other household risks impacted are animal pests and diseases and maize pests and diseases management.

Table 4-21: Impact of maize and livestock information on household risks

Variables	Frequency (%)
Improved planning and timing of agriculture activities	58 (31.69 %)
Improved food security	46 (25.14 %)
Improved selection of the appropriate maize varieties	22 (12.02 %)
Improved determination of optimal harvesting weather and storage	17 (9.29 %)
Timely animal pest and disease control	12 (6.56 %)
Improved maize pest and disease prevention	10 (5.46%)
High crop yields and incomes	8 (4.37 %)
Improved planning of labour needs	5 (2.73)
Prevention of erosion	5 (2.73)

The discussions at all FGD sites positively spoke about the maize information tips that included the control of pests, weeds and weevils with resultant increase in volumes of crop harvests. The use of maize information tips was perceived to be motivated by the impact on quality and quantity of production and ability to improve incomes and household consumption. The experience shared by a female and male participant at Murindagomo FGD and Trelwaney FGD respectively was like other FGD sites:

We used not to appreciate how much pests affected maize harvests. We maize crops was being attacked but often took for granted the harvests they took away from our sweat.

The knowledge from the combo made us stop losing bags of harvests to pests. We watched and controlled pests and our maize increased considerably. (Murindagomo FGD female participant)

If a farmer took a small tin and put some maize and weevils and observed the result after two months, they would see that almost half of the maize would be gone. This is how much from the field into our granaries we lost

maize to pests and weevils. The combo helped to cut these losses, and we have availability of more good quality maize crops and harvest. (Trelwaney FGD male participant)

The increased productivity of maize was discussed at all 5 FGDs, by both men and women. In the matrix assessing consensus, 10 participants shared significant experience on the increase in the quantity of maize harvest. Figure 4-6 shows a near balance in the contributions of men and women, with the latter mostly (10) being the first to speak on new issues related to how the maize information tips improved harvests, food availability, crops sales and food reserves. A participant from Murindagomo-FGD experienced an increase of eight 50 kg bags to her seasonal harvest since she started receiving and using maize information tips. The increase was associated with her household having food availability throughout the year. A male participant at Kawondera-1 FGD reported that the maize information tips caused an increase in the maize harvest and surplus they sold between 2018 and 2021. It was his view that the surplus he sold in the past was less by twelve 50-kilogram bags since he used the information tips.

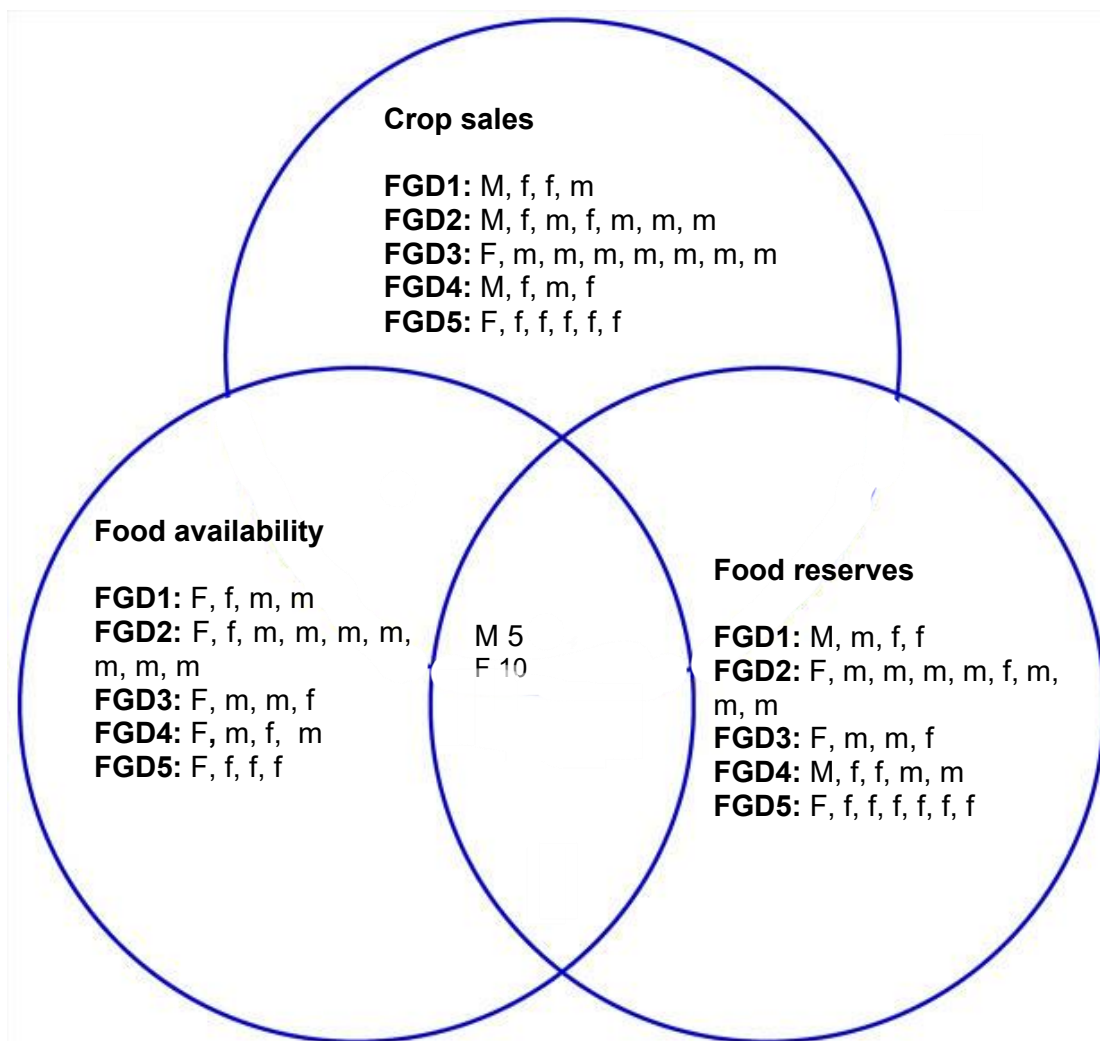


Figure 4-6: Impact of maize information tips on the increase in crop harvests

Information tips also impacted the household challenge of crop pests and diseases. At three FGDs reducing pests and diseases was attributed to increase in the health and productivity of the maize crop, assuring food availability than they had without the information. At two FGDs, four participants were of the view that improved management of crop pests and diseases had a share in increased surplus harvests. Households sold part of the surplus and were able pay for other needs, such as education and food. There were four FGDs, with five dissenting voices arguing that despite the sale of surplus the payments received were late and in a currency that resulted in negligible impact on their ability to pay for other expenses. The view was supported by most farmers at the FGDs, and this was constantly referenced as the reason behind the limited impact of the combo product on other household risks.

The livestock information tips impacted the household challenge of managing animal pests and diseases. At all FGDs, there was an appreciation of improved animal health after using the tips.

The participants discussed how the information tips received helped them to always buy vaccines and chemicals ahead of anticipated outbreaks of diseases. In addition, the early detection of signs of livestock illness, allowed timely treatment and seeking veterinary extension services. As shown in Figure 4-7, slightly more males than females were the first to contribute to key discussion topics on areas impacted by livestock information tips.

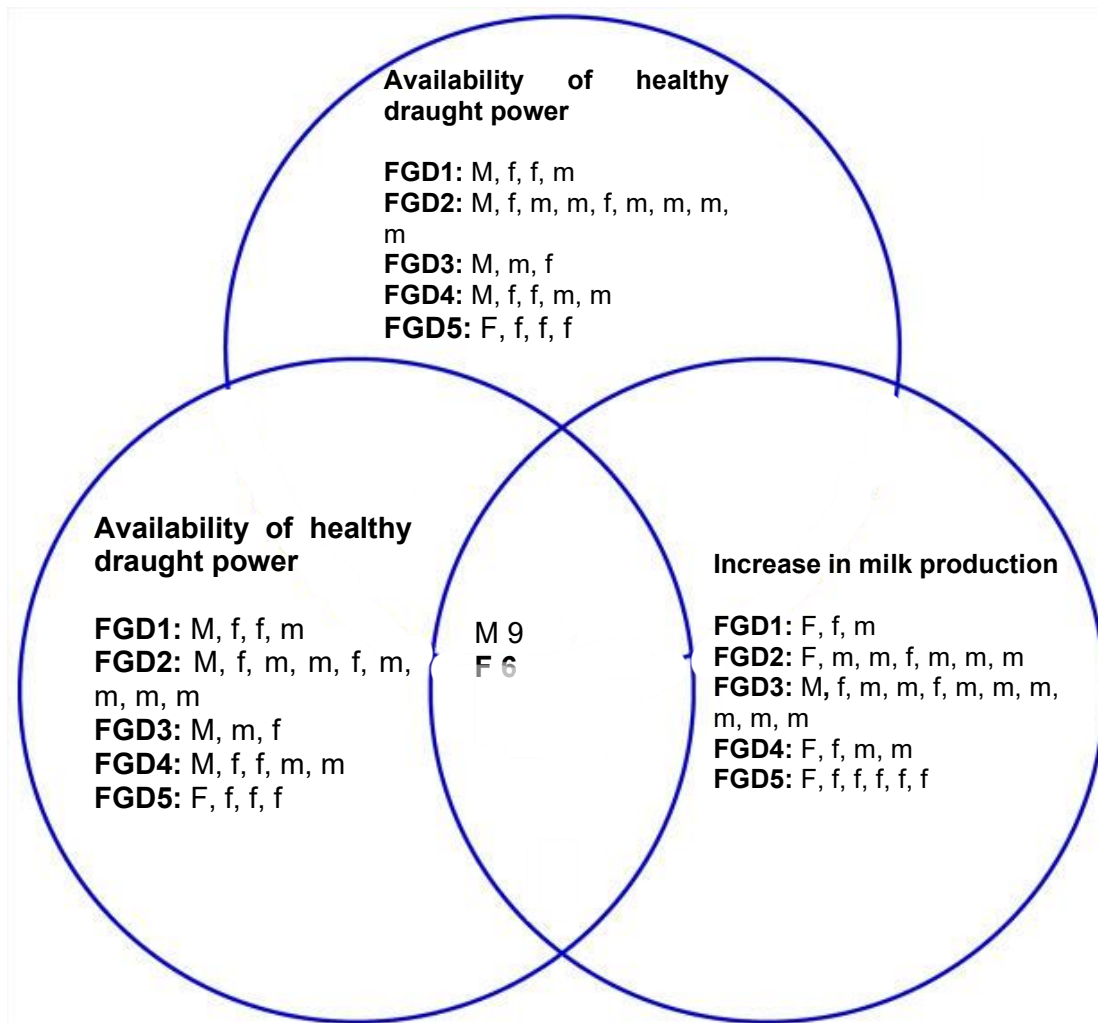


Figure 4-7: Impact of livestock information tips on livestock

Participants at Trelwaney and Murindagomo FGDs were convinced that their cattle were saved from the effects of January disease because of the timely information tips they received in 2018 and 2019. A female participant at Murindagomo FGD was supported by six other participants on her observation:

Before the information tips, we knew that the onset of rains was the beginning of a sorrowful life for farmers. Ticks multiplied and January disease was brought to life. Every household lost at least one cattle from the disease. In 2018 and 2019 in our area, if there are any farmers on the combo that lost their cattle then I might be mistaken. We heard stories from others, not us. We used the information tips and reminders to timely respond to prevent the outbreak from affecting our cattle.

A male participant from Kawondera-1 FGD spoke highly of the improvement in animal health because of the information tips. Availability of healthy cattle improved, and they annually used them as draught power in agricultural activities. Another male participant from Kawondera-2 FGD emphasised that to effectively use cattle in land preparation activities, their feeding, vaccination and health was a result of using the information tips:

To get good harvests a farmer needs healthy cattle from the start to end of the agriculture season. If one allows their cattle to be attacked by ticks, they will highly likely fall sick. The farmer risks being unable to undertake required farming tasks, and that affects their harvest. The combo taught us to always vaccinate and dip cattle. They can be used to the maximum in farming activities with the benefits of high food productivity.

A concern shared at all FGDs related to how the maize and livestock information tips seized with the closeout of the CSS programme. Farmers were concerned that crop and livestock tips can be season specific and the passage of time made some of inappropriate. New information tips are required in the event of new variants of diseases and pests. The lack of post programme access to the tips was a concern shared by both men and women. The view by a male participant from Kawondera-1 FGD was repeated in the other four FGDs:

The information service stopped when the combo ended, and we were left stranded. We were accustomed to and dependent on the information service in our farming ventures and we saw the benefits. They should have given thought to how we would continue to receive the information tips.

Farmers were provided with regular access to information tips on weather events through mobile phones. Table 4-22 shows how household risks were impacted by weather information service. Of the 11 categories of pre-CSS programme household risks only 4 appear on the impacts of weather information service. The household risks impacted include improved management of

animal and crop pests & diseases, food security and animal pest & disease management. The findings, with similarity to those of maize and livestock information tips have a relatively low representation compared to other results.

Table 4-22: Impact of weather information service on household risks

Variables	Frequency (%)
Improved planning and timing of agriculture activities	82 (51.57%)
Improved selection of appropriate crop varieties	19 (11.95%)
Improved crop pest & disease prevention	12 (7.55%)
Improved food security	11 (6.92%)
Improved animal pest & disease management	9 (5.66%)
Improved determination of optimal harvesting weather and storage	9 (5.66%)
Improved planning of labour needs	6 (3.77%)
Prevention of erosion	6 (3.77%)
Higher crop and livestock productivity and incomes	5 (3.14%)

The five FGD sites, had contributions from 23 women and men who generally concurred on the increase in crop harvests, and food availability after use of weather information. A female participant from Murindagomo FGD and male participant at Trelwaney FGD shared experience that recurred at other FGD sites:

We received information on when to expect rains and even hot temperatures. We timed the planting, weeding, fertilising, and harvesting of crops guided by this. Every time we used the information the crops were healthier and gave us high harvests. The information on rains and temperatures helped us harvest our crops on time avoiding crop losses from excess moisture. (Murindagomo FGD female participant)

Farmers not as informed as us might not see the value of weather information to productivity and food availability. Us who used it, we testify the impact on household food availability. We knew how unexpected rains damaged maize crops if we delayed harvesting. We ended using it to just feed chickens. Since the combo this did not happen, and we increased food availability. (Trelwaney FGD male participant)

There was very limited demonstration of the impact of the ZFU membership card on household risks. The household risk the card had potential to impact was the unavailable and fluctuating costly prices of goods and services. This is because the card was required for farmers to be eligible for discounts on the prices of goods and services for purchases at approved agro dealers. The five FGDs had only one (1) out of the 33 participants who had used the ZFU membership

card and benefitted on discounts from agro dealers in Chinhoyi, a town located about 60 kilometers from the study location, Murindagomo. The participant could not recall whether this happened during or after the implementation period of the programme. In the instance she used the card the discounted prices allowed her to buy more agriculture inputs than she would have done through unapproved agro dealers. She bought inputs for the vegetable garden, and this allowed for continued production of food for consumption and selling surplus to earn income for other household expenses. The participant described how she transacted:

I bought a 25 kg bag of maize seed for about \$4 less than the price that I would have paid in local shops. I used the savings to buy vegetable seeds and pesticide for my homestead garden. I use the garden for my household consumption and selling for income to use for other household needs.

The FGDs had 32 participants providing verbal confirmations that they had not used the membership card. The main reasons that emerged from the discussions included the high transportation costs and the inconvenience in the location of approved agro dealers. As there were no approved dealers at local business centres farmers required to travel the 50-to-60-kilometer distance to the town with approved agro dealers. The costs and inconveniences of such an arrangement were shared by a male participant at Kawondera-2 FGD which resonated with views at all other sites:

We wanted to benefit from the discounts on the card. This was not possible because of the cost to us. One needed \$6 to travel to and from town. If you bought bulky inputs such as maize and fertilizer, you expected to spend \$2 on transporting a 50kg bag from the agro dealer shop to the public transport station and then home. When I am in town, I would also need to buy food, another \$1. We calculated the money we spent; it would be more than the discount on the inputs. A farmer who bought their inputs locally would spend less.

The survey and FGDs had low utilization of WII. In the FGDs, 2 farmers out of 33 had received payouts in the region of US\$25 each from maize WII. They reported having used the payouts to buy agricultural inputs equal to 10 kgs of improved maize seed, which was not enough to meet their input requirements. However, they considered this a good start as they had to buy an additional 20 kgs. A female participant indicated that without the payout she might have had to reach out and burden her children with a request for additional money to buy the required seed but did not have to do so in this instance. Concerns raised by the two farmers was the lack of adequate communication and information when the payouts were made. After receiving the short message notifications that the wallet accounts had been credited with the amounts, there were no further details on the source and purpose. There was initial hesitance to use the money. FGD

participants that had not used the WII also raised concerns on lack of communication and information. At Kawondera-2 FGD three participants still had questions on how the WII was applied when farmers in the same area received payments, while others did not. From Murindagomo FGD, two participants expressed lack of awareness that maize WII was part of the combo product.

The CSS programme promoted the rearing of small livestock that included chickens, goats and rabbits. The rationale was the multipurpose use of the small livestock, as households could directly meet their food needs or sell some and use proceeds for productive and consumption needs and accumulating larger assets. Small livestock reproduce and increase numbers in shorter periods, than larger livestock. The survey results in Table 4-23, show that the household risks impacted by the promotion of small livestock were food availability (18.33 %) and reduced prevalence of livestock diseases (9.44 %) and increased income from the sale of livestock (9.44 %) that could impact food security through food purchases. The household risks have relatively lower representation compared to other impacted areas.

Table 4-23: Impact of livestock promotion on household risks

Variables	Frequency (%)
Increased number of livestock	60 (33.33 %)
Increased types of livestock	40 (22.22 %)
Increased food availability	33 (18.33 %)
Increased income from livestock	17 (9.44 %)
Reduced prevalence of livestock diseases	14 (7.78 %)
Improved quality of livestock	13 (7.22 %)
Reduced use of labour	3 (1.67 %)

All FGDs had overwhelming consensus on the general increase in the number of small livestock at homesteads since the CSS programme was launched. This was observed to have impacted food and nutrition security. From Kawondera-1, Povo, Trelwaney and Murindagomo FGDs, 18 farmers of mixed gender shared examples of households that sold small livestock to address food insecurity risks:

If my children wanted to eat poultry meat, they only needed to tell me, and that could be prepared. We no longer consumed poultry meat on Christmas days only. Even when I hosted respected visitors, I no longer worried about what relish to prepare for them as I had enough chickens in my fowl run.

The promotion of small livestock impacted the risk of rapid increase in prices of goods and services. At the Murindagomo and Trelwaney FGDs 10 out of 15 participants discussed how they used small livestock to cope with the rapid increase in the local currency prices of agricultural inputs. When needed they sold the chickens in United States dollars and used the same to buy agricultural inputs. The experience of a female participant at Trelwaney resonated with what others shared:

Buying agricultural inputs in the local currency was difficult. The prices increased every day, and local shops only wanted to be paid in US\$. Through chickens and goats, we found a way to counter this problem. A farmer would sell two goats or ten chickens for US\$ and they had enough money to buy the inputs. Before the end of the year, the chickens or goats would have been replaced through reproduction.

There was consensus at all FGDs that it was better to keep savings in small livestock than in the local currency. The perception was that asset-based savings would protect them from the loss of value had they kept their savings in local currency.

Table 4-24 presents the results of the overall assessment by the farmers, on how they perceived the combo product to have assisted them in responding to household risks.

Table 4-24: Assessment of the impact of combo product on household risks

Statement	Strongly agree	Agree	Do not know	Disagree	Strongly disagree
Combo product addressed household risks	0 (%)	69.09 (%)	1.82(%)	29.09 (%)	0 (%)

The results from the one-sample Wilcoxon signed rank test show that the respondents agreed that the combo product assisted them in addressing household risks. In the FGDs, the participants expressed satisfaction with the inclusion of multiple services in the combo, though they had strong reservations about not being able to access some of the services.

We were happy that the combo had several services, which is usually not the case with some programmes that have been implemented in our area. However, we are not happy that several of the services were just on paper, and we did not benefit from them. We cannot tell you whether we were satisfied or not with a service we could not access.

Though the combo product had impacted some household risks experienced by the farmers before programme the breadth of the areas is limited and largely not aligned with the situation and expectations of farmers.

In

Table 4-25 the study determined the likelihood of farmers continuing to use the combo product as a measure of sustainable adoption. Cumulatively, across all the services, 66 % of the selections were for the likelihood to continue using the combo product. On the individual services, most (94.55%) respondents were likely and highly likely to continue using weather information, followed by drought-tolerant input varieties (85,45%) and maize and livestock information (83,64%). The services that had the most mentions for unlikely and highly unlikely continued use were funeral cover (40 %) and ZFU membership (30,91 %).

Table 4-25: Rating likelihood of continuing to use the combo services

Service	Extremely likely	Likely	Neutral	Unlikely	Extremely unlikely
ZFU membership	5 (9.1 %)	29 (52.7 %)	4 (7.3 %)	16 (29.1 %)	1 (1.8 %)
Input discount	5 (9.1 %)	22 (40 %)	13 (23.6 %)	13 (23.6 %)	2 (3.6 %)
Drought-tolerant varieties	7 (12.7 %)	40 (72.7 %)	7 (12.7 %)	1 (1.8 %)	0
Livestock promotion	4 (7.3 %)	15 (27.3 %)	25 (45.5 %)	10 (18.2 %)	1 (1.8 %)
Funeral cover	5 (9.1 %)	17 (30.9 %)	11 (20 %)	20 (36.4 %)	2 (3.6 %)
Weather information	12 (21.8 %)	40 (72.7 %)	3 (5.5 %)	0	0
Maize & livestock information	7 (12.7 %)	39 (70.9 %)	8 (14.5 %)	1 (1.8 %)	0
Maize WII	6 (10.9 %)	37 (67.3 %)	8 (14.5 %)	4 (7.3 %)	0

Overall, the data suggests that the respondents were likely to continue using most services offered by the programme, except for the funeral cover, where a considerable number of respondents reported that they were unlikely to continue using it.

The Fisher's Exact test was used to determine whether age, gender, education status, and the well-being status of the household head had an association with the rating of the likelihood to continue using the combo product without some individual services. The results in Table 4-26 show that there was not a statistically significant association among most of the demographic characteristics and the ratings on the likelihood to continue using the combo product without some individual services. However, the results reveal that there was a statistically significant association between age and the ratings on the likelihood of continuing to use the combo product without the funeral cover ($p = 0.005$). A statistically significant association was also observed between age and the rating on the likelihood to continue using the combo without maize and livestock information tips ($p=0.048$) and maize and weather index insurance ($p=0.049$). Similarly, the results revealed that there was a statistically significant association between the education status and the rating on the likelihood to continue using the combo product without funeral cover ($p=0.007$), ZFU membership ($p=0.019$) and input discounts (0.024).

Table 4-26: Fischer's Exact Test Rating the likelihood to continue using the combo product without some services

Service	P value			
	Gender	Age	Education status	Well-being status of household head
Funeral cover	0.259	0.005	0.007	0.459
ZFU membership	0.423	0.311	0.019	0.400
Input discount	0.170	0.425	0.024	0.220
Drought-tolerant varieties	0.389	0.482	0.595	0.205
Livestock promotion	0.127	0.593	0.174	0.167
Weather information	0.492	0.126	0.194	0.307
Maize & livestock information	0.820	0.048	0.224	0.222
Maize WII	0.933	0.049	0.297	0.712

The FGDs had a mix of sentiments on the continued use of the combo product, and these were largely influenced by the experience of smallholder farmers during the implementation of the

programme. Generally, farmers that used a service expressed more willingness for continued use, than those who had not utilised it. In the analysis of consensus in the FGDs, all 33 farmers agreed that they continued using drought-tolerant input varieties, weather information, maize and livestock information tips based on knowledge acquired during programme implementation. The value of weather and crop and livestock information services was viewed in enabling better decision-making and management of activities in their farming enterprises and households. At all FGDs, 31 of the 33 farmers expressed the desire to continue receiving and using the information, but this had either stopped or become irregular since the CSS programme close-out. Weather information had only three out of 33 FGD participants confirming that they still received the tips, though this was erratic and therefore perceived as less helpful. The lack of regularity was seen as affecting the desire for continued use by the farmers.

The FGDs had 28 out of 33 participants making 84 contributions, agreeing that they no longer used all other services in the combo product. The dominant sentiments portrayed exasperation with how some services in the combo product could not be used and the already covered lack of tangible benefits during programme implementation. The participants discussed concerns, firstly on their inability to access some services during the implementation of the programme and secondly, on the lack of continuity of most services after the programme phased out. From all FGDs, 33 farmers variously expressed and supported each other on how they were not able to use agriculture input discounts because there were no arrangements with local input sellers for the benefit to be accessed during and after the programme. Farmers discussed concerns on the transaction costs, mostly transportation, they had to incur to access approved input suppliers that were located at business centres outside their villages and district centre.

There were 28 of the 33 FGD participants not willing to continue using the funeral cover because of the dissatisfaction with too frequent reviews of premiums and poor communication by the service provider. It was the view that when premiums were reviewed upwards the farmers were not informed in advance. In most instances the deductions were made wiping-out available mobile-money wallet account balances of the farmers. In some instances, the reviews resulted in farmers not affording the new premiums, and the policies lapsed. It was the view of the participants from three FGDs that the funeral policies should not have lapsed, had the provider considered their contribution history and the impact of the reviews of premiums on affordability. In four FGDs, fourteen participants were of the view that the premium contributions they had made were substantive enough for the provider to have considered offering support to farmers during the time they experienced difficulties associated with the Coronavirus disease (COVID-19)

outbreak, and when they struggled with household risks. At the Kawondera-1 and Kawondera-2 FGDs, participants suggested that if the service provider had considered the contributions made towards the funeral cover, they could have offered farmers repayable consumer loans to mitigate some of their risks.

There were more pronounced views from three FGDs, indicating the lack of information and communication on maize WII that negatively affected the desire for continued use of the service. At the Murindagomo FGD, four farmers were not aware that the combo product included maize WII. At two other FGDs, seven farmers were not aware of the eligibility criteria for compensation after risk. There were five farmers from three FGDs, who felt that they deserved to have been compensated after cyclones and drought affected their crops. This was not the case, contributing to lack of interest for continued use of the service.

A few (5) of the farmers from two FGDs raised concerns that they had not received their ZFU membership cards, yet these were required to access some benefits such as input discounts. The state of availability of the service during and after the phase-out of the programme was attributed to reduced confidence of the farmers to use the combo.

4.4.3. Improvements that could influence adoption of the combo product

Despite the results showing that the combo services impacted some of the household risks there was a general and emotive view that the design could have been better and inclusive. Of the 33 FGD participants, 28 wanted the combo product to directly impact their household risks. A female participant from Povo Business Centre shared a view that constantly came up at other sites:

The risks pushed us to participate in programmes introduced in our area. We participated because we wanted to get relief on how we struggled to feed and clothe our families. This was the case with most farmers that participated in the combo programme. We expected the programme to directly address our risks.

At all the FGDs there were perceptions of misalignment between the household risks and effects of the combo product. This led discussions to conclude that there was the lack of understanding or listening to the risks of farmers during the design of the CSS and other programmes. There were balanced contributions from male and female participants that information-based interventions must be balanced with others that provide practical and tangible change to household risks. A view shared by a female participant from Kawondera-2 FGD had similar sentiments expressed at the Povo, Trelwaney, and Kawondera-1 FGDs:

If I did not have household risks, I would not seek to join programmes. If I could afford to have my children attend school without lacking anything or paying for health care expenses when needed what would I be looking for in the combo? What pushes us to be in programmes is finding direct solutions to these risks. If the solutions are far-fetched as was with the combo that is when you find very few farmers taking an interest in participating.

A male ZFU community mobiliser in attendance at the Kawondera-2 FGD confirmed that the expectations had been brought-up in other interactions he had with the farmers in the district. He summed-up the experiencing of responses by farmers when invited to programmes:

When I invite farmers to meetings, they are not even afraid to ask me if it was similar to the combo where we only bring information but no direct solutions to our risks. They tell me we need to pay for health and education expenses now and not next year and if I cannot answer that then I should leave them.

Table 4-27 shows the frequency (in percentage) of survey results on other services that the farmers preferred added to the combo product. The service that the farmers most preferred included in the combo was access to loans, with 78.2% of the mentions.

Table 4-27: Other services preferred for inclusion in the combo product

Service	Frequency (%)
Access to loans	43 (78.2 %)
Medical Insurance	38 (69.1 %)
Education support	26 (47.3 %)
Continuity of service	20 (36.4 %)
Improved sharing of information on services	10 (18.2 %)
Local retail outlets for accessing benefits	10 (18.2 %)
Accessible/local in-person customer services	8 (14.5 %)
Consumption support	7 (12.7 %)

Similarly, from all FGDs, the inclusion of access to financial services involved contributions from all 33 participants. The need included both working capital loans, asset financing, and contract farming. Medical insurance had significant (69.1 %) recommendations for its inclusion in the combo. The FGD participants highlighted the need for families to be assured of timely access to quality healthcare services and not be forced to dispose of assets to cover healthcare expenses, or resort to ineffective measures. The survey had an equal (18.2 %) preference for 1) improved

sharing of information on services and 2) local retail outlets for accessing benefits. The five FGDs had twenty-three farmers highlighting how each season they required new information different from the past. It was the view that services such as weather, maize and livestock information tips were not supposed to be tied to the life cycle of programmes. The views at the five FGDs were that discounts on inputs require to be locally accessible through retail outlets to reduce transaction costs. Customer services with 14.5%, were discussed in FGDs with recommendations for additional accessible and local in-person customer care. At two FGDs, the contributions of nine smallholder farmers were that the telecentres were not very helpful when they had issues that needed to be resolved. The farmers at the Trelwaney and Kawondera FGDs believed that telecentres needed to be complemented by local physical walk-in help centres. A suggestion was made to collaborate with local schools in establishing accessible information centres for services extended to farmers. The lowest share (12.7 %) of preferred additions to the combo was consumption support. At three of the FGDs, contributions from seven participants pointed to the need for access to food or cash assistance for urgent needs during emergencies such crop damage or death of livestock. The perception was that during past emergencies desperation forced them to take measures that left them worse off, such as selling livestock and other productive assets.

Table 4-28 shows the benefits that respondents associated with the services they preferred added to the combo product. The results indicate that most (76.4%) farmers preferred the services for their impact on improving productivity.

Table 4-28: Importance of preferred services

Variables	Frequency (%)
Improve productivity	42 (76.4 %)
Assurance of health and well-being	33 (60 %)
Secure food access	17 (30.9 %)
Motivate other farmers to join	14 (25.5 %)
Ability to continue paying for combo product	11 (20 %)
Investment in economic diversification	10 (18.2 %)
Reputation in community	10 (18.2 %)
Invest in assets	5 (9.1 %)

There were 25 out of 33 participants at the FGDs, who perceived that preferred services would impact agriculture productivity. Regarding financial services, the discussions highlighted the ability to use these to invest in both agriculture and non-agriculture productive activities. The smallholder farmers elaborated on their willingness to repay the financing as expressed by a male FGD participant from Trelwaney:

You get a personal loan whether to farm or repair tractors or other needs then repay in instalments. I recall our fathers and grandfathers would get loans they repaid over 5 years in small instalments. But what you would have done with the loan will be massive and you quickly grow as a farmer.

At the Trelwaney and Kawondera-2 FGDs, participants shared examples of how contract farming had been used in tobacco farming and could be extended to other crops such as soya beans, maize and sorghum. Participants were of the view that financial services could improve and diversify their productivity and income and enhance their ability to pay for the combo product. Significant (60%) mentions were made on how preferred services could improve their health and well-being. At the Povo, Trelwaney and Kawondera-2 FGDs, eleven participants had consensus on how access to medical insurance could assure timely access to healthcare and regular availability of healthy productive labour. A male participant at the Kawondera-2 FGD stated:

We appreciate that the programme provided funeral cover for those that would have died. However, we felt they also needed to consider how those who are alive could live longer by providing medical insurance to our families. The medical insurance

must have included our old parents, as their health is our healthcare and financial burden.

A finding notable in the survey was how the respondents considered the impact of the preferred services on their reputation (18.2 %) and influence on other farmers (25.5 %). This linked with discussions in the FGDs, where the participants highlighted the importance of tangible benefits and the impact of programmes. It was generally shared by the participants that tangible benefits and impact were a source of self-esteem and respect and motivation for participation by non-participants. There was a small (9.1 %) subset of the respondents who saw the importance of the preferred services in improving their ability to invest in assets.

The Fisher's Exact test was used to determine whether gender, age, education status, and the well-being status of the household head, had significant association with the likelihood of preferred services influencing the decision to adopt the combo product. The results in Table 4-29 show, there was not a statistically significant association among all four variables and the views on the likelihood of the preferred services influencing the decision to adopt the combo product.

Table 4-29: Fischer's Exact Test on likelihood of preferred services influencing adoption decision-making

	P=value
Gender	0.546
Age	0.922
Education status	0.249
Well-being status of household head	0.267

4.4.4. Discussion

The combo product had mixed results for its impact on household risks that smallholder farmers had when the CSS programme was launched. From both the survey and FGDs results, drought-tolerant maize input varieties positively impacted household food production and income after the sale of surplus harvest. The impact of maize drought-tolerant input varieties on productivity and income observed in this study aligns with similar findings made in a study in Kenya. Ogada *et al.* (2020) found the use of drought-tolerant input varieties being attributed to 83 % increase in household income, on a sample of 433 farmers including some that had adopted, and some not adopted CSA practices in the Nyando basin of Western Kenya.

In this study, the findings exhibited a reasonable representation of the impact of livestock information services. However, there are few of the household risks experienced before the CSS programme was launched that were impacted, management of livestock diseases, and food security. Despite the limited household risks impacted the farmers spoke highly of how livestock information tips increased the number of small ruminants which had a role in addressing food insecurity and cushioning them against the rapid increase in prices of goods and service and devaluation of the local currency. Ogada *et al.* (2020) made relatable observations on how in Kenya small ruminants were an important savings mechanism that rural households liquidated to manage consumption and income needs. The positive impact of information tips on crop and animal productivity and incomes point to the important role that mobile phones can play as a channel for delivering crop and livestock extensions services. The finding resonates with observations from Bangladesh on a study of 150 farmers and in Nigeria with a sample of 270 farmers. In both contexts extension services provided through mobile phones increased farm productivity and incomes (Ogunniyi & Ojebuyi, 2016; Ahmad *et al.*, 2024). According to Ahmad *et al.* (2024) and Ogunniyi & Ojebuyi (2016) in Bangladesh and Nigeria the advantages farmers saw in the use mobile phones as a channel for delivering extension services include rapid and easier access to information, multiple types of information from production to marketing, strengthening farmer networks, and detecting crop diseases.

Similar to observations by Zougmore *et al.* (2021) in Ghana and Burkina Faso are drawn from this study on the impact of information tips on improved farmer decision-making in selecting agricultural input varieties, farming methods, application of inputs, reducing production costs and timing of farming activities up to harvesting. There are lots of similarities between the study findings and those from Ghana on the use of weather information services. A study of 555 farmers in six communities in Ghana found farmers using the services for decisions related to variety selection, cropping patterns, and timing of agriculture activities (Antwi-Agyei *et al.*, 2021). The study highlights the positive impact and importance of weather information tips to farmers on several of the household risks they experienced prior to the launch of the CSS programme. The tips contributed to increased agriculture productivity, food viability and access and the management of animal and crop diseases. Cumulatively households improved food security. The CSS programme used a single channel, mobile phones, to disseminate climate information to farmers. Though this generated positive impact there is the likelihood of a single channel not meeting the communication channel preferences of all smallholder farmers. In Ghana, despite the use of mobile phones radio had a higher utilization for accessing climate information by farmers (Antwi-Agyei *et al.*, 2021). The learning to be drawn is for service providers to include multiple channels for disseminating climate information to cater for the likely differences in the

preferences of end users. Despite the positive findings of this study, and those from other contexts referenced here, Owusu *et al.* (2020) had contrary observations on the impact of climate information on adopting farmers. In their study of 203 farmers from three districts in the Upper West region of Ghana, Owusu *et al.* (2020) found that climate information services did not have a significant impact on adopting farmers. The dissimilar findings in Ghana highlight the imperativeness of incorporating the uniqueness of context and encompassing understanding of the risks of households and their influence in shaping the types and anticipated impact of CSA programmes. In the study farmers had constraints in the utilization of weather information services during programme implementation. According to Misaki *et al.* (2018) & Antwi-Agyei *et al.* (2021) the constraints that farmers could experience in accessing weather information services include illiteracy, misalignment between supplied and needed information, timeliness of information dissemination, limited knowledge of climate change, inappropriate technical language and mistrust of information. In Zvimba District farmers were expressive of how they missed the information, and the gap created in farm decision-making since the service ceased which may be indicating that some of the constraints were not relevant in their context.

The study in Zvimba District demonstrated how the lack of a sustainable exit plan for services contributed to low-impact outcomes, despite the value that the farmers derived. In the FGDs, observations were made on how post programme, the services had become erratic to non-existent, despite the perceived value held by the farmers. The farmers were aware of how dynamic the risks they deal with are and the redundancy of information and knowledge from past seasons. Each new season, the farmers were expectant of timely information to use in farming decisions. Having a mechanism that would have sustained access to information was an apparent aspiration for the farmers. The findings by Zougmore *et al.* (2021) revealed critical elements in the design of information-based interventions that include having an elaborate business model for the service, appropriate communication, and intensified awareness.

A study of 1,172 Malawian and Zimbabwean farmers who adopted CSA practices in eight districts found higher levels of impact on productivity and income among the farmers who adopted multiple adaptation measures, than those who adopted a few (Makate *et al.*, 2018). In the current study, the farmers demonstrated a preference for the combo product and were largely not willing to have any of the services dropped but instead wanted more to be included as motivation for adoption. These findings point to the importance of CSA programmes providing a suite of interventions to farmers, as that brings robust complementarities on impact, as observed in Ethiopia by Teklewold *et al.* (2019). In Ethiopia, a study sample of 921 farmers revealed a high impact correlated to the

complementarities of interventions where multiple CSA practices were implemented that included agro-forestry, water management, improved and diversified crop inputs, inorganic fertilizers, soil management, and conservation agriculture (Teklewold *et al.*, 2019). An analysis covering three countries to determine the top ten priority CSA practices that farmers adopt revealed that each context had varied interventions. The study by Ouédraogo *et al.* (2015) quoted in Zougmore *et al.*, (2021) focused on Ghana (270 farmers), Mali (300 farmers), and Niger (300 farmers). It was observed that in each country, the combination of CSA practices was unique, leading Zougmore *et al.* (2021) to conclude that it was important to understand the needs and priorities of targeted farmers when designing CSA programmes. The conclusion supports observations made in Zvimba District by some FGD participants who were of the view that there was a lack of understanding of their risks in the design of the CSS programme.

The few farmers that used WII reported limited impact on household risks. The service did impact buying of improved maize input varieties, restoration of production and diversifying household income earning. On a sample of 353 farmers in Ethiopia Gebretsadik & Tesfay (2023) found WII insurance having similar impacts and in addition increasing the use of inorganic fertilizer, improved input varieties, increase in yields, food and nutrition security and access to health and sanitation services. In Kenya a commercial WII product, Kilimo Salama, was offered to maize farmers covering losses to drought and excess rains, with the cost of inputs as the basis for compensation. In Embu County WII was observed to positively influence farmer use of fertilizer and improved seed varieties and increased maize productivity that impacted food insecurity risks (Sibiko & Qaim, 2020). Mongolia has one of the most successful WII products that started as a pilot in 2006 scaling-up nationally by 2012 with penetration in 339 districts (Mogge, 2023). Despite a decline in penetration in 2015 the uptake has since been on an increasing trend, according to Mogge (2023). The Index Based Livestock Insurance aims to provide cover to livestock farmers in the event of loss due to extreme winter weather or natural disasters (Bertram-Huemmer & Kraehnert, 2018). If the disasters caused livestock mortality of 6% in the area of insurance farmers are eligible to receive payments. In Mongolia the payments from WII are attributed to insured herders having larger cattle herds those uninsured between years 2011-2013 (Bertram-Huemmer & Kraehnert, 2018).

Weather Index had low utilization and largely unfavourable impressions on its effectiveness to household risks. As most farmers had not benefitted from the insurance, they were less likely to continue using it. The study found failure to be paid after experiencing weather shocks and lack of information behind the negative perceptions smallholder farmers had about WII. This also

resonates with experience from Kenya, where according to Njue *et al.* (2018) the reasons farmers gave for dropping out were the failure to receive insurance payouts when they had experienced shocks. Similarly, lack of awareness of insurance was seen potentially influencing risks to adoption by farmers in Bangladesh (Al-Maruf *et al.*, 2021). Improving communication and information sharing and mechanisms of access to insurance beyond the programme are areas that required attention. This is particularly important in contexts where there is limited awareness and misconceptions on insurance. In Zimbabwe a study of 15 farmers by Maireva (2023) found that barriers to the uptake of insurance included not seeing the need, lack of incentives, negativity on insurance, lack of awareness on the details of the contract, high cost and constraints in access to the service.

The major challenges observed and areas of improvement on the CSS programme was the inclusion of services that remained in concept, as the farmers lacked access to some of them during implementation, for instance, input discounts, maize WII and funeral cover. The lack of access to the services contributed to a deficiency in acknowledgment of the impact of the combo product. Possibly, if the participating farmers had assured access to these services, better impact findings could have been obtained, comparable to those in Malawi and Zimbabwe, as observed by Makate *et al.* (2018). These findings on the influence of multiple interventions on households have further significance on inclusion of multi-sector partnerships in the design and implementation of CSA programmes. In Mongolia a notable feature of the index-based livestock insurance was the involvement of other financial service providers, particularly commercial banks in selling the product. These already had interface with farmers which could positively influence trust and the likelihood of product uptake. In Mongolia insured farmers accessed loans with discounted interest rates from participating banks and this expanded financial inclusion (Bertram-Huemmer & Kraehnert, 2018). In the FGDs smallholder farmers lamented how despite premium payments they had made for the WII and funeral cover the service provider did not consider extending other financial services to mitigate vulnerabilities from the outbreak of COVID-19. In designing the combo consideration could have been made to also include opportunities to access other financial services to support farmers to meet some of their day-to-day consumption and productive needs. The range of services would exceed the competence and capacity of a few service providers but require several partners to be involved. The combo also must be acknowledged for its uniqueness in including a funeral cover that paid-out in the event of death of the insured.

The study findings exposed the misalignment between the household risks and the scope of the CSA practices in the combo and their impact. The 11 household risks that farmers had before the CSS programme were minimally (4) represented in the major areas impacted by the combo product. The household risks included food insecurity, unavailable and fluctuating costly prices of goods and services, livestock diseases and deaths, lack of non-farm skills and unemployment, low crop producer prices, illness in the household, lack of capital, insufficient grazing and cropping land, outbreak of crop pests and diseases, lack of drinking water and poor access to extension services. Out of these food insecurity, crop pests and diseases and livestock pests and diseases had been somewhat impacted by the combo product. Some of these impact areas are featured in the analysis by a few scholars on risk factors that influence farmers when deciding to adopt CSA practices. A study by Elrick-barr *et al.* (2015) in Australia found illness and the inability to pay for household expenses as sources of risk that influenced the farmers in deciding on the adoption of CSA practices. Similarly, in Ethiopia, Fayso (2018) observed illness and healthcare care needs to have a similar influence on farmer decision-making. Considering the findings of the study and the examples cited, it can be observed that when a factor is a source of risk and influences decision-making, and is addressed by a CSA programme, this suggest significance to the farmer. This justifies the questioning whether and how the voices of farmers are incorporated in engagements on the prioritisation of risks and co-creation of programmes. Where smallholder farmers are actively engaged in the identification and analysis and prioritization of risks and risk responses the expectation is for enhanced chances of alignment between expectations and interventions. Smallholder farmers may also take accountability and ownership of application and outcomes where they shaped and can identify with some of the risk responses included in programmes. Further, programme designers will be guided on what combination of interventions and collaborations are necessary to satisfy smallholder farmers and motivate their sustained adoption of CSA programmes. Whitfield *et al.* (2018) note the risk of focusing much on the technical aspects of CSA practices at the expense of other multidimensional aspects of the ecological circumstances of the farmers that shape their prioritisation and decision choices. What is drawn from this, concerning the current study, is caution on predominantly focusing on the production aspects and the impact of CSA practices, while not paying attention to social aspects that may include household risks. In this study, the farmers perceived their household risks as sources of risk and had expectations that they would be directly targeted by the programme. Restricting risk driving and influencing adaptation decision-making to climate change stressors may inadvertently limit the scope in the areas of impact attributable to CSA programmes. The broadening of risks of the farmers to household risks could further open the understanding of more diverse areas to be impacted by CSA programmes. As this study has shown, the farmers were in search of and appreciated more diversified impact areas associated with their day-to-day needs. The impact areas for the study were determined by the farmers, which suggested the

weight they attached to these for their households. The farmers used their household risks to weigh the worthiness of the CSS programme. The argument by Whitfield *et al.* (2018) posits the adoption of systems and multidisciplinary approaches in dealing with CSA practices. The diverse household risks found in this study could have been aptly addressed with a multidisciplinary approach. This further highlights the importance of programmes implementors to understand the risks of farmers targeted by CSA programmes and exploring their role in decision-making and inclusion in targeted actions and outcomes. As the study found, the expectation to have practical needs of households addressed was a priority that the FGD participants believed influenced their and other farmers' participation in programmes.

The low uptake and lack of sustainable adoption of CSA practices have been observed in several contexts (Peterson, 2014; Sibiko *et al.*, 2018; Strauss *et al.*, 2021). The study revealed elements on the type and delivery of services that could influence trends in adoption. Deliberately addressing the practical needs of smallholder farmers is perceived to be a driver for both scale and sustainability of adaptation. Smallholder farmers expressed the difficulties of being part to CSA programmes that did not provide immediate relief to their social and economic risks. While information-based interventions were appreciated sustaining participation was seen as a challenge if the well-being of families remained vulnerable. The perception created was that some non-adopters delayed making decisions because they wanted to observe how the practical needs of early adopters were impacted. There was considerable interest for continued use of the combo services if access gaps experienced during implementation of the CSS programme were addressed. In addition to addressing the gaps, the study revealed product types and product features preferred to improve scale and sustainability of adoption. Farmers preferred combo type products to include access to loans, medical Insurance, education support and consumption support. When these and other combo services are offered preferred improvements in the features included mechanisms to assure continuity of services, improved sharing of information, more accessible service, and information outlets. The suggested product additions resonated with household risks that prevailed before the CSS programme and constraints observed in other studies such as lack of knowledge, and high transaction costs to access services.

4.5. Chapter summary

The smallholder farmers experienced diverse climate change and household risks before the launch of the CSS programme. Both the climate change and household risks influenced the risk perception and decisions of the smallholder farmers to adopt the combo product. There were some smallholder farmers whose views were that the household risks influenced their risk

perception independent of the climate change factors. The smallholder farmers perceived that household risks generated negative risk perceptions that included loss of self-esteem, stigma from community, failed parenting and deviation from norms expected by communities. The desire to avoid these risks were perceived to be the drivers of decisions to participate in programmes. Not all services in the combo product had been used by most of the smallholder farmers. Some of the services could not be used as there were no locally accessible service providers. The services that had been used by smallholder farmers had mixed results on the impact on household risks. Household risks were largely not prominently impacted by the combo product. Few household risks were impacted by the combo product but comparatively they had very low representation in the results. Few of the household risks impacted by the combo product were interrelated to food security and these included increased crop and livestock productivity, increased incomes, improved crop and livestock pest and disease management. There were expectations and preferences for programmes that directly addressed the household risks rather than indirect approaches. The misalignment between the household risks, their risk consequences and the expectations of smallholder farmers can be associated with lack of sustained adoption and scale of outreach by the CSS programme. Farmers were dissatisfied that the combo product did not directly impact what they perceived as their urgent and survival imperatives.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This final chapter presents the conclusions of the study, and the findings including highlights of the key arguments they generate, the convergence and divergence with previous research. The chapter also outlines the relevance of the findings to CSA programme design in pursuit of impacting sustainability and scale in the adoption of adaptation measures. Finally, the chapter addresses recommendations and areas for possible further research.

5.2. Summary of findings

The purpose of the study was to explore the drivers of risk perception that in turn influenced adaptation appraisal and decision-making by smallholder farmers that adopted CSA practices. The study focused on the experiences of smallholder farmers who adopted the combo product promoted by the CSS programme in Zvimba District. The primary focus of the exploratory study was on household risks and how they influenced the decisions of the farmers in adopting the combo product. The study further sought to establish whether the combo product had impacted the household risks that smallholder farmers had at the time that the CSS programme was launched. The summary is a consolidation of findings from a survey of fifty-five farmers, FGDs with thirty-three farmers, and interviews with eight key informants. The study was guided by the following research questions:

1. What is the description of climate change risks that smallholder farmer households experienced in Zvimba District?
2. What is the description of household risks that smallholder farmers experienced in Zvimba District?
3. Can the influence of climate change risks in the adoption of the combo product be validated?
4. What influence did household risks have in the adoption of the combo product by smallholder farmers?
5. What pre-existing household risks were impacted by the adoption of the combo product in Zvimba District?

Research question 1: What is the description of climate change risks that smallholder farmer households experienced in Zvimba District?

Key finding: Smallholder farmers experienced multiple climate change induced risks that were of concern to them because of the consequences on the agriculture-based livelihoods.

The predominant view is that climate change stressors are sources of risk that shape risk perception and in turn, drive farmers to adopt adaptation measures. Various authors such as Pathak *et al.* (2018), Shabnam *et al.* (2019) Ogisi & Begho (2023) have documented the occurrence of climate-induced stressors that include extreme temperatures, increasing frequency and intensity of droughts, floods, and cyclones, and uneven rainfall pattern. The current study confirmed the presence of climate change stressors that most farmers regarded as concerns, because of the association with negative changes and impact on their livelihoods. The climate change stressors experienced in the communities before the launch of programme include changes in rainfall pattern, scarcity of water, loss of grazing land, change in temperature, flooding, land degradation, siltation of rivers, livestock diseases and death, and crop diseases and failure. The negative impact of these climate change stressors on the farmers' livelihoods included poor crop harvests, food insecurity, crop and livestock diseases, and livestock deaths. Similar negative impact of climate change stressors on the livelihoods of farmers are noted by Ray *et al.* (2019), Whitfield *et al.* (2018), & Ogisi & Begho (2023). The climate change stressors experienced in the study location were identical to those that Ahmed *et al.* (2021) and Mashizha (2019) found in their studies of communities in Bangladesh and Zimbabwe, respectively. The findings affirm that the CSS programme was a relevant response to the context where it was implemented, given the occurrence of the climate change stressors and the negative impact experienced by the communities.

Research question 2: What is the description of household risks that smallholder farmers experienced in Zvimba District?

Key finding: Smallholder farmers experienced multiple household risks that they perceived as risks with consequences on the well-being and survival of the families and their self-esteem.

Smallholder farmers experienced multiple household risks that include food insecurity, lack of access to water, illness and lack of access to healthcare, unavailability and fluctuations in prices of goods and services, unaffordable education expenses, unemployment, outbreak of animal diseases, lack of access to input and output markets, crop pests and diseases, death of livestock, lack of farm implements and capital. The occurrence of similar household risks among farmers

adopting CSA practices has been highlighted by Elrick-barr *et al.* (2015), Cavanagh *et al.* (2017) & Fayso (2018). In the FGDs smallholder farmers preferred for these challenges to be regarded as household risks that preceded climate change stressors. The climate change stressors were viewed to have only caused the intensification of pre-existing household risks and compounding the complexity of their risk environment. There were arguments by some, that it was coincidental that climate change stressors became prominent, since they believed household risks already stressed them. Situations were discussed of past similar CSA programmes that were promoted in the district, yet household risks persisted. The negative risk consequences that smallholder farmers associated with the household risks include a deterioration in the well-being of household members, death, loss of assets, loss of self-esteem, and negative community labelling. How farmers perceived household risks, and their co-existence with climate change stressors exposed the limitations of exclusively scientific climate change responses. The farmers had high expectations for CSA programmes to include interventions that directly and practically respond to household risks. The expectations for programmes to increase agriculture production and consequently indirectly address the household risks was perceived as inadequate and not in sync with the urgency of the farmers' needs. Farmers perceived the lack of scale and sustainable adoption of the combo product to be associated with the misalignment between the composition of the combo product and their expectations for practical solutions to priority risks.

The study affirms the concurrent presence of multiple and complex risks to smallholder farmers. In such a context, responding to only one risk without due consideration of the others and the prioritization by those affected and expected to act may result in the misalignment between intended and actual programme outcomes. This challenges CSA research and programme practitioners to shift from a single risk focus and balance their analysis and consideration within a complex risk framework. In doing so CSA practitioners must consider the climate scientific facts but equally attend to the psychological, social and economic priorities of smallholder farmers.

Research question 3: Can the influence of climate change risks in the adoption of the combo product be validated?

Key finding: Climate change stressors influenced the decision of most farmers to adopt the combo product.

The influence of climate change risks on risk perception and adaptation decision-making is extensively documented. The intention of the study was not to challenge this rich area of knowledge. The study focused on merely validating whether the climate change stressors had indeed influenced the decision to adopt the combo product. The finding would also reveal the complexity of the risk environment of farmers as they considered the adoption of the combo. The findings of the study validated that most farmers had been influenced by climate change stressors to adopt the combo product.

The validation of the occurrence and influence of climate change factors in adaptation affirms knowledge that has been extensively covered. It was not the intention of the study to challenge this existing knowledge. Rather the study contributed to expanding the breadth of knowledge on the drivers of adaptation by smallholder farmers. CSA research and programme practitioners are challenged to expand and add their application of knowledge beyond the usual mainstream discourse to bring to the fore new perspectives. The new perspectives may shade light into some of the challenges and opportunities to unlocking scale and sustainable adoption of CSA practices.

Research question 4: What influence did household risks have in the adoption of the combo product by smallholder farmers?

Key finding: Household risks influenced most smallholder farmers to adopt the combo product.

The study was influenced by observations made by Elrick-barr *et al.* (2015), Cavanagh *et al.* (2017), and Fayso (2018) on how social and economic factors can be sources of risk that are important to consider for their contribution to risk perception and decision-making by farmers when adopting CSA practices. In the argument of Cavanagh *et al.* (2017), farmers may prioritise addressing household risks ahead of the performance of the adaptation measures. The study explored how smallholder farmers associated the household risks with their decision to adopt the combo product. They distinguished risk consequences they believe were caused by the household risks and their desire to prevent and mitigate them because they perceived them as imperative to the well-being of their families. Strong sentiments were expressed on how food insecurity intersected with health, and income insecurity of households. During the FGDs, examples were shared of how food insecurity had a share in the deterioration of sick family members as food was essential for the effectiveness of treatment. Food insecurity had forced households to liquidate various forms of assets. The forced liquidation of the assets had

households not obtaining the true value of their assets, while leaving them poorer than before. Local communities perceived responsible parenting to be demonstrated in adequately providing families with basic needs, including food. When this did not happen communities perceived this as failed parenting, a state which most participants were not comfortable with. In addition, household heads feared losing the respect of their children in the event of failure to meet their food, health, clothing and education needs. The moral standing of parents was at risk when children asked them questions on the lack of access to basic needs. There were overwhelming views on how the desire to prevent these risks pushed community members to participate in programmes.

The smallholder farmers expressed with the high confidence that household risks influenced the decision to participate, not just in the CSS programme, but any others launched in the community. Of note were sentiments expressed in FGDs that participation in programmes had become speculative. In some instances, attention was not paid to the programme objectives but anticipation that perchance they would encounter solutions to household risks. The finding that most farmers agreed that household risks influenced their decision to adopt the combo is significant.

The design and implementation of CSA programmes has prominently focused on the technical approaches to prevent and mitigate climate change risks on smallholder farming systems. This has resulted in the neglect of some risk drivers that have notable contributions to decision-making by smallholder farmers. The study's findings challenge the adequacy of responses that focus only on the scientific or technical aspects of climate change when there is a disconnect with risks prioritised by farmers. The findings confirm the challenges to farmer participation in programmes when what they perceive as priority risks are not considered. Emotive exchanges in FGDs typified the insistence that interventions that assured tangible and direct impact on household risks were important. Though acknowledging the value of information-based CSA practices, the study revealed perceptions of fatigue with the approach and recommended balancing with interventions providing practical outcomes. The farmers referenced the government supported *Pfumvudza* programme for its ability to combine CSA practices with real solutions to their challenges, with high input costs. Promotion of conservation farming practice was backed by a pack of agricultural inputs, one of the household risks identified in this study.

The study further explored whether some of the results could have been determined by independent variables such as age, gender, education status, and the well-being of the household

head. This was stirred by some studies that focused on these social and economic factors, and their role as determinants for the adoption of CSA practices, which is different from being sources of risk. Authors such as Zakari *et al.* (2019), Nnodim & Raji (2020) and Musafiri *et al.* (2022), documented how age, gender, experience, income and education level are determinants of adoption of CSA practices. There have been inconsistent findings on the role of some of these factors, with the same demographic characteristics yielding varying associations on how they determined adoption decisions. As noted by Zakari *et al.* (2019), there is no consensus on how age is a determinant of adoption. As an illustration, the findings by Akroush *et al.* (2017) on a study in Jordan, age was observed not to have a significant influence on the adoption of water harvesting technologies by farmers. On the contrary, a study in Kenya revealed that the age of the household head had a positive influence on the adoption of animal manure. The reasoning was that increasing age comes with experience that farmers used in determining the value of the practice and accumulation of a sizeable head of cattle from which manure was accessed (Musafiri *et al.* 2022). However other writers viewed old age as a barrier to adoption, with older farmers tending to prefer sticking to conventional farming methods against the risk-taking orientation of younger farmers (Negera 2022; Ogisi & Begho 2023).

The significance of understanding the influence of gender on some of the findings, follows the acknowledged dominance of women, despite inequalities, in agricultural production and their higher than men vulnerability to the effects of climate change (Food Agriculture Organization, 2017; Huyer & Partey, 2020; Khatri-Chhetri *et al.*, 2020; Ogisi & Begho, 2023). In different contexts, gender has been found to have varying effects on the adoption of CSA practices. In Vietnam, Tran *et al.* (2019) found that gender had a positive relationship with the adoption of CSA practices by farmers. In contrast, Musafiri *et al.* (2022) found gender having a negative effect on the adoption of agroforestry among Kenyan farmers, with women adopting more than men. In Ethiopia, Negera (2022) observed that men tended to adopt CSA practices more than women. The current study did not find a significant association between gender and the influence of household risks on the adoption of the combo. Both men and women were equally affected and prioritised household risks as risk drivers with consequent influence on the decision to adopt the combo product.

The education status of the farmer is viewed as having the likelihood to determine the adoption of adaptation measures. Zakari *et al.* (2019) and Ogisi and Begho (2023) observe that education enhances the ability to receive and understand information, thus increasing the probability of adoption and application of CSA practices. The positive influence of education on the adoption of

adaptation measures was observed by Akroush *et al.* (2017) among Jordanian farmers adopting water harvesting technologies, and by Musafiri *et al.* (2022) among farmers adopting animal manure in Kenya. In South Africa, Mthethwa *et al.* (2022) found the education level of the farmer affecting the adoption of CSA practices. In the instance of the current study, the farmers across diverse education statuses adopted the combo. There was no significant association between education status and the influence of household risks on the adoption of the combo product.

Okumu *et al.* (2023) observe that farmers involved in off-farm income-generating activities would be less likely to participate in CSA practices. The reason for this was that such farmers would have limited contact with sources of agricultural extension information that would expose them to CSA practices. In contrast, as observed by Pagliacci *et al.* (2020), the off-farm income sources could have a positive impact on adoption, as these diversify income that could be used to mitigate risks associated with the adoption of CSA practices. In the current study, the types of income sources could not be associated with determining risk perception and adaptation decision-making. Though most farmers depended on agriculture, their other income sources at the time of the study included off-farm income-generating activities, remittances, pensions, and wage labour.

Fisher's Exact analysis did not establish significant influence of most demographic characteristics of the farmers on the adaptation choices they made. The differential observations made on how the same demographic factors had variable determination of adoption decision outcomes could be indicative of the presence of other underlying factors not prominently revealed in other studies on the adoption of CSA practices. In the case of the study, the constant factors attributed to influence risk perception and adoption decision-making were climate change stressors and household risks. What was evident from the FGDs, and survey was the diversity of household risks that were perceived as risks. The risks could be unique to some but not all households which could probably be the underlying explanatory factor as to why farmers sharing the same demographic characteristic could have different adoption decision outcomes. The study revealed that understanding household challenges from a risk perspective could better inform the risk and decision-making context of farmers.

Research question 5: What pre-existing household risks were impacted by the adoption of the combo product in Zvimba District?

Key finding: The combo product impacted some but not all the household risks that smallholder farmers had at the time the CSS programme was launched.

The study found low utilisation of most of the combo services by the farmers. This implied most farmers were not able to exhaustively determine how more than half of the combo services could have impacted their household risks. Despite the low utilisation, some of the combo services made positive impact on about four of the eleven household risks experienced by smallholder farmers when the CSS programme was launched. Of the four the three prominent household risks that were impacted by the combo product included food insecurity, crop pests and diseases, and livestock pests and diseases. There was low representation of the impact on unavailable and fluctuating prices of goods and services. The use of drought-tolerant varieties, crop, and livestock information tips was associated with increased crop productivity, which in turn increased food availability and improved income that enabled spending on basic needs. Maize and livestock information tips improved planning and timing of the procurement and use of agricultural inputs, the management of the health of crops and livestock pests and diseases and increase in both the number and type of healthy livestock. Weather information services improved planning and timing of agricultural and household activities, and the effective application of agricultural inputs. These combo services cumulatively improved productivity and incomes that contributed to improved food security. The impact areas revealed from the study are largely aligned with those from other contexts where CSA practices have been implemented. Ogada *et al.* (2020) found the use of drought-tolerant crop varieties and small ruminants contributing to household income and assets in Western Kenya. In Ghana, weather information tips improved the planning and management of agricultural activities (Zougmore *et al.*, 2021). Three impact pillars of CSA practices include 1. increased agricultural production and income, 2. promoting and enhancing the resilience of agricultural systems, and 3. reducing the emission of greenhouse gases (Williams *et al.*, 2015). The study found that some of the services in the combo product contributed to the first two impact areas, even though a noteworthy number of the services were not accessible.

The scope of the household risks impacted by the combo services was limited by some elements in the design of the CSS programme. Some services, though included in the combo product, had limited accessibility by farmers. In the survey, there were five out of the eight services that had been used by less than ten of the fifty-five farmers and these included funeral cover, ZFU card, weather index insurance, input discounts, and livestock promotion. The ZFU card was a prerequisite for a farmer to benefit from agricultural input discounts. In part, some of the farmers reported not having received their cards, which consequently meant they were not able to enjoy

the input discounts. From a related perspective, the study found that accessing the input discounts required the availability of preselected and agreeable agro dealer shops. The study found that most locations did not have these shops, which made it impossible for farmers to access.

The lack of awareness and trust of WII and funeral cover points to weaknesses partly of farmer capacity building and the effectiveness of the delivery channels. As CSA programmes introduce services that are unfamiliar and suspect to farmers it is imperative to strengthen awareness through capacity building of targeted end users. Providers must consider capacity building strategies that simplify technical knowledge delivered in platforms and medium that are easy to access and understand. The content of capacity building must focus on ensuring that farmers understand in-depth the features and implications of the services, their relevance and value within the context of different risks and vulnerability profiles. The delivery of the services must be consistent and with mechanisms for assuring sustained access to reduce the risk of losing the momentum, motivation and reputation generated with end users. Multiple innovative approaches must be explored to deliver capacity building adapting to the preference of end users. There is potential risk that the depth and effectiveness of capacity building and communication content may become less effective as more players get involved. This may happen where primary generators of information, such as weather and agronomic tips, use intermediaries to deliver extension services to smallholder farmers. The ability of intermediaries to transmit, analyse and interpret the information will require that they are appropriately trained and there are mechanisms for quality control including regular monitoring of effectiveness and end user feedback.

The use of ICTs in agriculture has been associated with positive impacts that include increasing productivity, adoption of improved high yielding inputs, use of fertilizers, and access to input and output markets (Oyelami *et al.*, 20222). The study has shown the positive contribution of weather, crop and livestock information tips provided to farmers using mobile phones. A major weakness revealed by the study is the discontinuation of the services after the programme closed. This raises questions on the role of generators of technical information such as Meteorological Services Department of Zimbabwe and AGRITEX in the delivery of mobile phone based extension services. This is considered against the role of intermediaries that develop the enabling ICT platforms. As their normal way of operating institutions such the Meteorological Services Department of Zimbabwe and AGRITEX must be adequately resourced to have the capacity to own, actively and sustainably use ICTs to directly interface with the end user farmer. The Meteorological Services Department of Zimbabwe and AGRITEX must be generating the content, packaging and delivering it to the farmer. This will assure that the break in information access by

smallholder farmers is prevented. The role of ICT technology companies will be focused on the development and dissemination of the enabling platforms.

The study points to the importance of co-creation of programmes with smallholder farmers and any other stakeholders expected to play a role in the execution of programmes. This will also contribute to reducing the gap between expectations and outcomes of programmes. This can be achieved by incorporating farmer experience, needs and priorities in the design and selection of interventions in CSA programmes. Indigenous knowledge systems shape how individuals and groups within communities relate amongst themselves and with their environment. Smallholder farmers had already experienced and adapted to some adversities and risk consequences before climate change. The indigenous beliefs and practices of the farmers have allowed them, overtime to effectively overcome adversities driven by social, economic and environmental factors. How they managed through these adversities and the knowledge and experience gained needed to have been incorporated in the CSS programme. It is imperative that CSA programmes understand, be informed and build on pre-existing indigenous knowledge systems. The study revealed the importance of parental and community values and relations on how households respond to risks in the decision-making processes and the areas they expect to be impacted by programmes. In such instances changing practices will require to go beyond the individual but the broader community value system and institutions. CSA programmes that are farmer-centred need to find ways to allow indigenous knowledge systems to shape and be integrated in interventions responding to the effects of climate change. The incorporation of indigenous knowledge systems in adaptation could create pathways for interventions that address social adaptation, structural adaptation, and institutional adaptation (Mbah *et al.*, 2021). As found in this study farmers perceived their motivation to be driven by incorporating aspects of their knowledge systems in the design and implementation of programmes.

It is observed that climate change stressors and household risks had synergistic risk effects that created a complex vulnerability context that jointly influenced the decisions of farmers to adopt the combo product. The preference for farmers is CSA programmes that integrate and concurrently address both climate change stressors and household risks. This resonates with observations by Elrick-barr *et al.* (2015) on the importance of considering the social and economic circumstances of smallholder farmers for their potential influence in the adoption processes.

It is an oversimplification that CSA practices are adopted primarily because of the intent of smallholder farmers to prevent and mitigate the threats from climate change stressors. This

maybe the intent for programme designers, but not always necessarily that of the intended programme participants. The study demonstrated that there are also household risks that shape adaptation decision making. CSA practitioners that fail to incorporate the multiplicity of smallholder farmers' risks may find misalignment between intended programme outcomes and the impact they make on households. A few of the household risks of smallholder farmers had been impacted by the combo. This misalignment can be one explanatory variable to challenges that CSA programmes have had with scale and sustainability of adoption. Farmers expressed their opportunistic participation in CSA programmes driven by the intent to find practical solutions to survival imperatives. Additionally, they expressed how some farmers dropped out while others never joined because of what they perceived as a disconnect between their priority needs and the services offered by the programme. CSA programmes need to be creative in finding mechanisms for integrating immediate and practical solutions to survival imperatives with approaches that respond to the medium to long term effects of climate change.

5.3. Conclusion and recommendations

The study findings affirm the validity of the process-based approach espoused in the Model of Private Proactive Adaptation to Climate Change (MPPACC), on understanding farmer adaptation decision-making, from risk appraisal to adaptation appraisal and decision-making. What is evident from the study is that in the risk appraisal phase, the concern for the farmers was not just dealing with climate change risks, but concurrently, the household social and economic risks with risk consequences on their livelihoods. The study confirmed the presence and role of both climate change-induced stressors and household risks as drivers of risk perception and decision-making in the adoption of the combo product. It is concluded that the CSS programme directly targeted responding to the climate change risk drivers which were not necessarily representative of the totality of what was perceived and prioritised by smallholder farmers at the time the programme was launched. In the MPPACC, risk experience is an essential element contributing to risk and adaptation appraisal. As the study revealed, most farmers had experience with both climate change risks and household risks that they attributed to have influenced their risk perception. Therefore, risk perception and the decision to adopt the combo product were concurrently driven by factors external and internal to smallholder farmer households. At any given point, households experience multiple external and internal risk drivers, both of which could have been considered for their cumulative and synergistic impact on risk perception and adaptation decision-making. The demographic characteristics of farmers are crucial elements that have been associated with determining the adoption of CSA practices. However, they are not necessarily household risk drivers that could influence the risk context and risk perception of the farmers. They can be

determinants in the appraisal of adaptation actions. It is concluded that in some instances climate change and household risks can be experienced by households independent of gender, age and educational level of the smallholder farmers. Further research should include investigation of the factors that underly the difference in adaptation decision outcomes when the population groups share the same demographic characteristics.

The perceived failure of the programme to address what farmers viewed as the internal household risk drivers drew the most frustration during discussions and were attributed to both dropouts and lack of interest in adopting the combo product. The perceptions from the FGD sessions implied that in the design of the programme, there were no engagements with the farmers to better understand the multiple risks that households were experiencing. It is concluded that by adopting the combo product farmers had expectations to find solutions to their household risks. The study reveals the complexity and competition between climate change risks and household risks on their influence on smallholder farmer decision-making. The study reveals the weight of both risks as smallholder farmers perceived these to have influenced their decision to adopt the combo product. In such instances attempting to compare and exclude one at the expense of the other may create a misalignment between services provided and expectations of smallholder farmers.

A few of the combo products were used by the farmers, as the programme had not made adequate local, cost-effective, and sustainable arrangements for access. The study found that some farmers had not received their membership cards which were required for eligibility to access some services. In addition, there were no accessible pre-approved retail outlets where farmers could use their membership cards to benefit from input discounts. Though few of the services were used by the farmers, there were notable areas where the household risks had been impacted by the combo product: improved household food security, increase in crop yields, and improved management of crop and animal pests and diseases. Despite the challenges with access to some of the services and if the opportunity was presented, the farmers still expressed willingness to continue using the services. This affirmed the worthiness of the services to the farmers. The farmers expressed their preference for diversified and blended services as part of CSA programmes to allow multiple climate change and household risks to be addressed. The other recommended improvements to the combo product included access to loans, medical insurance, education and consumption support, accessible retail, and customer care outlets, sustainability of services, and improved sharing of information. It is imperative for programmes to deliberately engage farmers to understand the different dimensions and interconnectedness of their risk context and drivers, and the role of indigenous knowledge systems and their influence in adoption decision-making. There must be concurrent consideration of the perspectives of farmers on these aspects in the design of CSA programmes.

When CSA programmes are designed, consideration must be made for the inclusion of mechanisms that assure sustainable continuity and access after implementation, to increase chances for retention and scale of outreach and appreciation of the impact. The limited access to some of the services was a major contributor to negative perception on the worthiness and impact of the services on the farmers. The lack of mechanisms to access some of the services during and after the phase-out of the CSS programme negatively affected the expectations to continue using the services. It is imperative that CSA programmes are purposely designed with clear mechanisms to ensure that farmers access services post-programmes. To this end CSA programmes should deliberately consider strategic multi-sector partnerships with market system private, public and civil society actors whose inclusion must be informed by climate change, household social and economic and other risks prioritized by farmers. Consideration must be made for a suite of interventions that balance short-, medium- and long-term outcomes for the farmer households.

The study findings raise pertinent observations based on a small sample selected from one district and only three wards and could benefit from large samples in diversified contexts. When the findings are considered in isolation and as a single small sample study generalization is a challenge. The likelihood of the findings being applicable to other contexts is possible when considered in the context of other studies from different contexts but with similar findings. In Kenya Cavanagh *et al.* (2017) found the risk of non-adoption, and lack of sustainability when smallholder farmer needs are not met. Farmers in an agro-forestry project questioned the rationale of planting trees when they were not planting enough maize to meet their consumption needs. In Ethiopia Fayso (2018) found illness of household members and access to healthcare as considerations in adaptation. In Australia Elrick-barr *et al.* (2015) found illness or injury, inability to pay for household expenses and emergencies, job loss and unemployment, and change to quality of life to have influenced decision-making. The similarity of findings across different countries could be indicative of the likelihood of applicability of findings in other regions. In addition, this could also be highlighting the importance of future CSA related research to consider presence and influence of multiple risks to smallholder farmer decision-making.

Smallholder farmers did not see appeal in programmes that had a narrow focus on their risk context. Research must broaden and deepen understanding of the scope of household social, economic and other risk dimensions and interplay with climate change risks and their significance to farmers as risk drivers. Despite the narrow focus of the study on household risks it revealed the complexity of their risk environment.

The study was conducted almost two years after the closure of the CSS programme. The timing was important to capture the findings related to sustainability in utilisation and impact of the combo. There may be important findings that could be missed because of challenges related to memory recall by the smallholder farmers. In addition, some of the farmers were no longer available, resulting in a smaller than desired sample. The recommendation is for longitudinal studies implemented through all phases of the CSA programme cycle from assessment of risks, through implementation and post-implementation. This would increase the chances of availability of most farmers who would have participated in the CSA programmes.

Poor communication and lack of information were observed weaknesses in the utilization of the funeral cover and WII. Also, the call center services were found not very helpful as farmers had issues they felt were not resolved. A holistic consideration must be for the inclusion of key communication content, channels and accountabilities to eliminate information-based barriers to utilization.

APPENDICES

Ethical clearance certificate

ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr A Hamadzirip

STUDENT NO:
18018295

PROJECT TITLE: **Examining the drivers of adoption of climate-smart practices in smallholder farming systems of Zvimba district in Zimbabwe.**

ETHICAL CLEARANCE NO: **FSEA/22/IRD/02/0507**

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof J Francis	University of Venda (Institute for Rural Development)	Supervisor
Dr J Zuwarimwe	University of Venda (Institute for Rural Development)	Co - Supervisor
Prof S Mpandeli	Water Research Commission, Water Utilisation in Agric	Co - Supervisor
Mr A Hamadzirip	University of Venda	Investigator - Student

Type: **Doctoral Research**

Risk: **Minimal risk to humans, animals, or environment (Category 2)**

Approval Period: **June 2022 – June 2025**

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- The project leader (principal investigator) must report in the prescribed format to the REC:
 - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project
 - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
 - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC retains the right to:
 - Request access to any information or data at any time during the course or after completion of the project.
 - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.
 - withdraw or postpone approval if:
 - Any unethical principles or practices of the project are revealed or suspected.
 - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
 - The required annual report and reporting of adverse events was not done timely and accurately.
 - New institutional rules, national legislation or international conventions deem it necessary

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: May 2022

Name of the RESSC Chairperson of the Committee: **Prof TS Mashau**

Signature




Letter of information and informed consent

RESEARCH ETHICS COMMITTEE

UNIVEN Informed Consent

Appendix B

LETTER OF INFORMATION

Title of the Research Study : Examining the drivers of adoption of climate-smart practices in smallholder farming systems of Zvimba district in Zimbabwe

Principal Investigator/s/ researcher : Hamadziripi Alfred

Co-Investigator/s/supervisor/s : J. Francis, J. Zuwarimwe & S. Mpandeli

Brief Introduction and Purpose of the Study

Despite the positive impact from the implementation of CSA practices their low adoption rates and limited sustainable implementation by smallholder farmers raises questions on whether enough is known on the drivers of adaptation adoption decision-making. The inability to address the barriers to scale and sustainability in the adoption of CSA practices will exacerbate the contribution of human actions to climate variability and change & the vulnerability and poverty of communities whose livelihoods are dependent on agriculture. The cumulative challenge is the failure to develop policies and programmes that sufficiently address the needs of small-holder farmers, achievement of development goals and containing the effects of climate variability and change.

Climate Smart Agriculture practices that include crop intensification, conservation agriculture, contour ridges, mulching, zero tillage, micro-irrigation systems, improved fallows and inputs been implemented in Mali, Mozambique, Malawi, Mali, New Zealand, Zambia, Kenya, Ghana, Zimbabwe, and other countries. The practices have demonstrated positive results in restoring assets, production, and soil fertility, reducing use of water, greenhouse gas emissions and operating costs with significant impact on increasing productivity and incomes of farmers (Aune

et al., 2017; Mango et al., 2017; Partey et al., 2017; Musvoto, 2019). However, despite the impact few farmers adopt the practices, uptake remains localised, and questions have been raised on continued practising in several countries including Guatemala (Phuong et al., 2017; Mase et al., 2017) and South Africa (Smith et al., 2017). The reasons attributed to low adoption of CSA practices are varied but include weaknesses in supportive institutional and policy frameworks, low educational competency of farmers, inadequate resources, incompatibility of technologies to contexts, high transaction costs for accessing the technologies and limited data and lack of access to information (Williams et al., 2015; Sibiko et al., 2018; Teame & Hagos, 2019;)

The aim of the study is to identify the drivers of risk perception that in turn influence decision-making by small-holder farmers in adopting CSA practices using as sample of 105 farmers from rural Zvimba district of Mashonaland West province in Zimbabwe. The research will use an exploratory research design to understand the breadth of the needs and their significance as sources of risk and subsequent influence on decision-making in adopting CSA practices. In particular, the study will use the exploratory sequential mixed methods design to collect and analyse data in interrelated phases to allow for extensive and deeper understanding of the issues. The first phase of the study will be qualitative and aimed at collecting and analysing data, using Atlas ti.8 to understand the needs that small-holder farmers had when CSA practices were promoted. In addition, why the needs were important to households will be clarified to determine the types of risks they generated and the influence on the decision-making processes. In the first phase, the study will establish the service combo benefits that were promoted, those adopted and still being used and the expected benefits from the services. The study will explore if any unmet needs were associated with risk elements that may have influenced decision-making. The primary sources of data in will be small-holder farmers and key informant experts from the organizations that were involved in the implementation of the Scaling-Up Climate Smart Agriculture Solutions for Smallholder Farmers in Zimbabwe.

The findings from the first phase will be used to identify themes that will inform the design of quantitative tools for the second phase. The quantitative data to be collected will identify and analysed using SPSS to illustrate the existence and significance of any cause-effect association between needs and risks and decision choices. In addition, analysis will be made of the link between unmet needs and risks and other types of services preferred by small-holder farmers and their relevance in decision-making processes. The findings from the identified relationships will inform those factors that must be included in the decision support tool for deciding on the types of services to consider in designing CSA practices and complimentary or integrated services.

Outline of the Procedures

The study population are 2,737 small-holder farmers in Zvimba district that participated in the Scaling-Up Climate Smart Agriculture Solutions for Smallholder Farmers in Zimbabwe (CSS) programme. At the end of the programme 146 farmers had purchased the service combo and 2,591 decided not to adopt the service combo. A combination of purposive sampling, convenience and snowball sampling will be used to select farmers that that will participate study out of the 146 farmers were involved in the CSS programme in Wards 5, 6, 10 and 20. Focus group discussion sessions will be guided by a focus group topic guide with predetermined questions that will be followed by probing as required during the discussion process. The focus groups will be asked the what and why questions to clarify the different and specific types of issues around needs, impact, and decisions as experienced by the small-holder farmers. At each FGD there will be a team of 2 comprising the facilitator and note taker that will take written notes on the responses and other comments made by the small-holder farmers. In addition, a tape recorder will be used during the sessions. After the focus groups the findings, using STATA will be clustered into common categories, themes, that will be incorporated into the survey questionnaire as response options to questions.

The household survey will be one-on-one questionnaire guided interviews with respondents self-reporting to questions administered by the researcher. The questionnaire to be uploaded to a data collection application will include a combination of questions that require responses to be captured using rating scales, checklists and binary questions.

Risks or Discomforts to the Participant

There are no anticipated risks and discomforts to participants associated with study.

Benefits

Climate variability and change is a threat to agriculture, livelihoods of communities, poverty, and development. The promotion of CSA practices is part of efforts to respond to the occurrence and effects of climate variability and change. The low adoption of the CSA practices by farmers is a concern for policymakers, researchers, programme implementers, and small-holder farmers considering the financial, time, and human resources they commit to promote and implement adaptation measures.

This study will shade insights on whether deeper analysis should also consider social, or consumption needs that may have risk implications on small-holder farmers. The study might therefore contribute to existing knowledge on understanding the drivers of risk appraisal and adaptive capacity appraisal and their influence on small-holder farmer decision-making in adopting CSA practices. This might improve the knowledge on types and quality of public and private sector services that are necessary and appropriate for small-holder farmers exposed to adaptation measures.

Contributions, such as this study, towards efforts to increase scale of adoption and sustainability in the implementation of CSA practices are imperative to agriculture livelihood systems and development. If more farmers can use proven practices this may increase the chances to contain and adapt to the effects of climate variability and change. The study will develop a decision support tool that might provide guidance on the needs that must be considered when designing and promoting CSA practices. This may inform the scope of support services and actors that could be necessary to include in the design and promotion of CSA programmes with the intent to increase scale and sustainability of adoption.

The findings from this study may therefore benefit farmers, policy makers and programme implementers, researchers and private sector involved in agriculture, food security, climate variability and change, development, and poverty.

Reason/s because the Participant May Be Withdrawn from the Study:

Participation in the study will only be based on informed voluntary consent by participants. In addition, participants will have the right to withdraw, from the study at any given time without any obligation to explain.

Remuneration

There will be no provision of any monetary or material remuneration for participants in this study. The timing for community engagement and feedback meetings is planned to be brief and focused to fit within a maximum of two hours which is anticipated not to necessitate any refreshments to be provided to participants.

Costs of the Study

The planned field activities will be within the residence and official working bases of participants that will not result in any participants needing to incur any material cost to participate in the study.

The lead researcher will be responsible for all operational costs associated with the study that will include costs for research materials and assistants.

Confidentiality

At the beginning of each focus group and household survey session an explanation will be provided to participants in the vernacular language detailing their rights to participate and withdraw and confidentiality of participants. The names of interviewees will remain anonymous. Where verbatim quotes will add value to the findings the concerned individuals will be requested for permission to use their statements but the real names or other personally identifying details will not be used in the report.

Research-related Injury

The focus of the study and data to be collected is considered of a generic nature that is not anticipated to cause any harm to participants. The study does not include any experimentation with humans and animals.

Persons to Contact in the Event of Any Problems or Queries:

Please contact the researcher (+27 82 827 6486), my supervisor (+27 76 409 3976) or the University Research Ethics Committee Secretariat on 015 962 9058. Complaints can be reported to the Director: Research and Innovation, Prof GE Ekosse on 015 962 8313 or Georges Ivo.Ekosse@univen.ac.za

General:

Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, (*Alfred Hamadziripi*), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: __,
- I have also received, read and understood the above written information (*Participant Letter of Information*) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant	Date	Time	Signature
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I Hamadziripi Alfred (*Name of researcher*) herewith confirm that the above participant has been fully Informed about the nature, conduct, and risks of the above study.

Full Name of Researcher

Hamadziripi Alfred	Date ...22/3/2022....	Signature
--------------------	------------------------------	-----------------

Full Name of Witness (If applicable)

.....

Date

Signature.....

Full Name of Legal Guardian (If applicable)

.....

Date.....

Signature.....

Please note the following:

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level- use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counseling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. a wrong date or spelling mistake, a new document has to be completed. The incomplete original document has to be kept in the participant's file and not thrown away, and copies thereof must be issued to the participant.

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