AN INVESTIGATION ON THE PRODUCTIVITY AND DIETARY DIVERSITY OF CONSERVATION AGRICULTURE PRACTISING AND NON-PRACTISING SMALLHOLDER FARMERS: A CASE STUDY OF BINDURA DISTRICT.

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

A dissertation submitted in partial fulfilment of the requirements for the Bachelor of Science Honors Degree in Agricultural Economics and Management.

By

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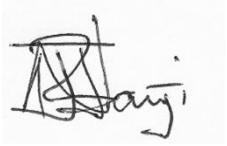
Signed: 

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DECLARATION

I hereby declare that the research project entitled **An investigation on the productivity and dietary diversity of conservation agriculture practising and non-practising smallholder farmers: A case study of Bindura District**submitted to Bindura University of Science Education, Faculty of Agriculture; Department of Agricultural Economics, Education and Extension, is a record of an original work done by me under the guidance and supervision of Dr L Musemwa and this work is submitted in partial fulfilment of the requirements for the award of a Bachelor of Science Honours in Agricultural Economics and Management. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree of diploma.

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DEDICATION

I dedicate this work to my family who put their trust in me and kept on paying my school fees. I appreciate them for making it possible for me to achieve my dream through the provision of resources and financial assistance. I love you my family. May the dear Lord bless you.

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ABSTRACT

Conservation agriculture (CA) has emerged as a promising approach to address agricultural challenges and enhance food security in Bindura District, Zimbabwe. This descriptive survey research aimed to identify challenges, assess yield variations, and evaluate dietary diversity among CA practicing and non-practicing farmers. A mixed research approach was employed, involving 100 participants selected through random sampling. Data collection utilized questionnaires, key informant interviews, and observations, while analysis was conducted using ANOVA. Results revealed significant challenges in CA implementation, including uneven distribution of resources, shortage of inputs, lack of evidence, untimely distribution of inputs, labor shortages, pests and diseases, and limited security. Furthermore, yield comparison indicated higher average yields among practicing (3.08±0.112) compared to non-practicing (2.49±1.094) farmers, contributing to enhanced agricultural productivity. Similarly, practicing farmers exhibited higher household dietary diversity scores (HDDS) (7.84) compared to non-practicing farmers (6.9), highlighting the potential of CA in improving dietary diversity and nutritional outcomes. Based on these findings, recommendations are proposed to address identified challenges and promote the adoption of CA, including implementing policies to ensure equitable resource distribution, strengthening extension services, and enhancing access to inputs and technical support. In conclusion, this study underscores the importance of CA in addressing agricultural challenges and enhancing food security in Bindura District, emphasizing the need for concerted efforts to overcome implementation barriers and maximize its benefits for smallholder farmers.

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LIST OF ABBREVIATIONS

CA – Conservation Agriculture

HDDS – Household Dietary Diversity Score

FAO- Food and Agriculture Organization

FfF – Foundations for Farming

CIMMYT- International Maize and Wheat Improvement Centre

NGO – Non Governmental Organization

ZImVAC – Zimbabwe Vuklnerable Assessment Committee

GOZ – Goverm,ent of Zimbabwe

NDS- National development strategy

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CHAPTER 1

INTRODUCTION

1.1 Backgroundof the study

The escalating global population growth and evolving dietary patterns have heightened the demand for food production worldwide. Climate change-induced disruptions have adversely affected crop yields in many regions, straining natural resources like soils (Mujere, 2022). Notably, the agricultural sector emerges as a pivotal contributor to economic development, GDP, food security, employment, and household dietary diversity, particularly in developing nations like Zimbabwe (Weiner, 1988). Post-Zimbabwe's independence in 1980, efforts focused on redressing historical disparities and promoting rural equity, marked by the establishment of agricultural institutions and land reform initiatives (Weiner, 1988). However, despite these strides, challenges such as low agricultural productivity, soil degradation, dysfunctional markets, and adverse macroeconomic conditions persist, exacerbated by climate change impacts, particularly on rain-fed agriculture (Donovan & Casey, 1998; Mupangwa et al., 2008). In response, relief measures, including widespread food aid and agricultural input assistance, have been deployed.

The emergence of dry spells in Southern Africa has underscored the imperative for conservation agriculture (CA) to enhance crop yields, particularly in rain-fed systems. Over the past six years, s2mall-scale farmers in Zimbabwe have embraced CA, notably through initiatives like Pfumvudza/Intwasa (Lowe, 2011). Conservation agriculture, pioneered by Brian Oldreive from Foundations for Farming (FfF), emphasizes practices like crop rotation, mulching, and minimum tillage methods, aimed at improving soil health and productivity (Twomlow, 2008). Despite challenges such as climate change-induced droughts and rising input costs, CA adoption has shown promise, with evidence of significant yield gains, especially in areas with robust support from NGOs and research institutes (Mazvimavi et al., 2009).

Conservation agriculture offers several advantages, particularly in the face of climate change. Firstly, its emphasis on minimum soil disturbance helps to maintain soil structure and fertility, mitigating the impacts of erosion and soil degradation exacerbated by extreme weather events

like heavy rainfall and droughts. Secondly, practices such as permanent soil cover through mulching and crop residues help to conserve moisture, reducing water loss through evaporation and improving soil moisture retention during dry spells. Thirdly, crop rotation and diversified cropping systems promoted in conservation agriculture enhance resilience to climate variability by spreading risks associated with weather fluctuations. Additionally, reduced tillage and soil cover practices contribute to carbon sequestration, helping to mitigate greenhouse gas emissions and combat climate change. Overall, conservation agriculture serves as a sustainable and climate-smart approach to farming, offering resilience against the adverse effects of climate change while promoting long-term soil health and productivity.

Conservation agriculture plays a pivotal role in enhancing dietary diversity, particularly in regions prone to food insecurity and agricultural challenges. By promoting sustainable farming practices such as minimum soil disturbance, permanent soil cover, and crop rotation, conservation agriculture helps to improve soil health and fertility, thereby increasing agricultural productivity and crop yields (Scopel et al., 2013). These practices contribute to the maintenance of soil moisture levels, reducing water stress on crops and enhancing resilience to droughts and erratic rainfall patterns (Pannell et al., 2014). Additionally, conservation agriculture reduces reliance on external inputs such as fertilizers and pesticides, making farming more cost-effective for smallholder farmers (Brouder & Gomez-Macpherson, 2014).

The adoption of conservation agriculture principles also leads to diversified cropping systems, allowing farmers to grow a variety of crops that can meet diverse dietary needs and provide a more balanced and nutritious diet (Chinseu et al., 2019). Moreover, by improving soil health and reducing environmental degradation, conservation agriculture contributes to the long-term sustainability of agricultural systems, ensuring that future generations have access to an adequate and reliable food supply (Von Loeper et al., 2016). Overall, conservation agriculture serves as a cornerstone for promoting food security by enhancing agricultural productivity, resilience to climate variability, and the sustainability of farming systems.

However, Zimbabwe's agricultural sector grapples with persistent challenges, including climate change-induced droughts, declining yields, and economic constraints (Lowe, 2011). Despite efforts to boost productivity through initiatives like the Pfumvudza program, challenges persist,

with smallholder farmers experiencing low yields compared to commercial counterparts. This underscores the need for sustained interventions to address underlying systemic issues and enhance agricultural resilience to climate change. Government policies and programs such as the fast-track land reform program and command agriculture aim to improve production and mitigate climate change impacts. Nevertheless, concerted efforts are required to bolster smallholder farmers' productivity and achieve sustainable agricultural development in Zimbabwe.

1.2 Problem statement

Climate change has of late posed challenges to the agricultural sector in many countries including Zimbabwe. The recorded impacts of climate change and variability, records show a 0.4^0C rise in temperature over the yearsand there has been a rise in the number of hot days with a decrease in the number of cold days (Bailey, 2021).There has been an increasing concern about the future of agriculture in Sub-Saharan Africa due to the accelerating soil degradation (Oldeman et al., 2009; Kumwenda et al.,1998; Sanginga and Woomer, 2009) and threats of climate change (Lobell et al., 2008), have raised the need for new and more adapted cropping systems that increase production whilst conserving the natural resource base (Wall, 2007; Kassam et al.,2009; Thierfelder and Wall,2009). Conservation agriculture has been one of the solutions thathave been controversially discussed (Gilbert,2012) as a cropping system that can mitigate the negative effects of climate change, and declining soil fertility under a range of farming systems (Hobbs,2007; Kassam et al.,2009). Zimbabwe confronts a severe challenge of food insecurity, particularly evident in its rural regions. The 2024 Zimbabwe Vulnerability Assessment Committee (ZimVAC) report paints a troubling picture, projecting that over 2.7 million rural Zimbabweans will grapple with food insecurity during the peak hunger period from January to March 2024. Despite concerted government efforts and assurances, this stark revelation underscores the pressing necessity to confront food shortages head-on and bolster household resilience. The pervasive nature of food insecurity not only threatens the immediate well-being of millions but also undermines the long-term stability and development of Zimbabwean communities. Addressing this multifaceted issue requires comprehensive strategies that address underlying socio-economic factors, bolster agricultural productivity, and foster sustainable livelihoods.

1.3 Research questions

1. What are the challenges being faced in the implementation of CA in Bindura District?
2. Do yields for CA spractisingand non-practising farmers vary in Bindura District?
3. Is there variation in the dietary diversity for CA spractisingand non-practicing farmers in Bindura District?

1.4 Research Objectives

Main Objective

To investigate the productivity and dietary diversity of conservation agriculture in Bindura District

1.4.1 Specific objectives

1. To determine the challenges being faced in the implementation of CA practice in Bindura District.
2. To investigate if yield varies across CA spractisingmembers and non-practising members in Bindura District.
3. To assess if dietary diversity varies amongst CA practisingand non-practising farmers in Bindura District

1.5 Hypothesis

1. There is a significant difference in yields between farmers practisingpfumvudza and those not practisingpfumvudza
2. There is a significant variation with the dietary diversity of farmers practicing pfumvudza and those not practicing Pfumvudza

1.6 Significance of the study

The significance of the study findings extends to various stakeholders, each with distinct interests and roles in addressing food insecurity and promoting sustainable agricultural development in Zimbabwe.

For government officials and policymakers, the study findings provide valuable insights into the effectiveness of current agricultural programs, such as Pfumvudza/Intwasa, in addressing food insecurity and enhancing agricultural productivity. By understanding the impact of these initiatives on smallholder farmers' livelihoods, policymakers can make informed decisions regarding resource allocation, program implementation, and policy formulation. The findings may also guide the development of targeted interventions aimed at improving access to resources, enhancing market linkages, and promoting sustainable farming practices.

NGOs and development agencies play a crucial role in implementing and supporting agricultural development programs in Zimbabwe. The study findings can inform their project design, monitoring, and evaluation efforts, ensuring that interventions are evidence-based and responsive to the needs of smallholder farmers. Additionally, NGOs and development agencies can use the findings to advocate for policy changes, mobilize resources, and collaborate with other stakeholders to scale up successful interventions and address systemic barriers to food security and agricultural sustainability.

For smallholder farmers and farming communities, the study findings offer practical insights into the benefits and challenges of adopting conservation agriculture practices like Pfumvudza/Intwasa. By understanding the impact of these practices on productivity, dietary diversity, and household food security, farmers can make informed decisions about their farming practices, resource allocation, and livelihood strategies. The findings may also empower farmers to advocate for their needs, access support services, and participate in collective action initiatives aimed at addressing common challenges and promoting sustainable farming practices.

For researchers and academics, the study findings contribute to the growing body of knowledge on conservation agriculture, food security, and rural development in Zimbabwe. The findings may inspire further research inquiries, methodological innovations, and interdisciplinary collaborations aimed at advancing understanding and informing evidence-based interventions.

Additionally, researchers and academics can use the findings to inform teaching, training, and capacity-building activities, ensuring that future generations of agricultural professionals are equipped with the knowledge and skills needed to address complex challenges in the sector.

1.7 Limitations and delimitations of the study

The study faced several limitations, including financial constraints, geographical challenges, and logistical hurdles. The costs associated with conducting extensive field research, especially in remote rural areas, limited the scope of data collection and the frequency of follow-ups. Geographical challenges, such as difficult terrain and poor infrastructure, further complicated access to certain smallholder farming communities, potentially leading to underrepresentation of these areas in the study. Logistical issues, including the availability of transportation and the coordination of fieldwork teams, added to the complexity of the research process. To mitigate these limitations, the research team employed a stratified sampling method to ensure diverse representation across different regions, prioritized cost-effective data collection techniques such as surveys and remote sensing, and established partnerships with local organizations to facilitate access and logistical support. These measures helped to minimize the impact of the limitations on the study outcome, ensuring a more comprehensive and reliable analysis of the productivity and dietary diversity among smallholder farmers practicing conservation agriculture in Zimbabwe.

1.8 Outline of the research project

The research is organized into five chapters, each addressing a critical aspect of the study on productivity and dietary diversity among smallholder farmers practicing and not practicing conservation agriculture in Zimbabwe.

Chapter 1: Introduction provides an overview of the study, including the background, problem statement, objectives, and significance of the research.

Chapter 2: Literature Review synthesizes existing studies on conservation agriculture, productivity, and dietary diversity, identifying gaps in the current knowledge and situating the research within the broader academic context.

Chapter 3: Methodology details the research design, including the sampling techniques, data collection methods, and analytical approaches used to conduct the study, ensuring a robust and systematic investigation.

Chapter 4: Results, Findings, and Discussion presents the findings from the data analysis, offering detailed statistical comparisons and thematic insights, and interprets these results in the context of the research questions and existing literature.

Chapter 5: Summary, Conclusion, and Recommendations summarizes the key findings, discusses their implications for policy and practice, offers recommendations, and suggests areas for future research. Additionally, the research includes References to all cited works and Appendices containing supplementary materials such as survey instruments and detailed data tables.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter serves to define the important concepts as well as defining terms used during this study focusing mainly on conservation agriculture and its impact towards productivity of smallholder farmers. This chapter contains a review the studies done on conservation agriculture and its contribution to dietary diversity as well as the overall food security statuts. The chapter goes on to provide a summary of the literature review, highlighting the gaps that exist in other studies.

2.2 Definition of key terms

2.2.1 Conservation agriculture

This type of farming encourages a permanent soil cover, a diversity of plant species, and minimal soil disturbance, such as no tillage. Conservation agriculture is based on three principles: permanent soil cover of at least 30%, crop species variety, and minimum mechanical soil disturbance through direct seed and fertilizer placement (FAO 2024). In addition to restoring damaged land, conservation agriculture can stop losses on arable land. Increased water and nutrient efficiency, as well as better and maintained crop production, are all benefits of conservation agriculture, which also improves biodiversity and natural biological processes both above and below the ground surface (FAO 2024).When practicing conservation agriculture there is a combination of zero tillage and intercropping or crop rotation (Donovan 2020). Conservation agriculture ensures sustainability so that agriculture ends up not producing greenhouse gases and reduced contribution to climate change. Conservation agriculture practices vary and the Pfumvudza program is also another way of conservation agriculture (Ian Scoones 2021)

2.2.2 Production

Production refers to the economic procedure of converting inputs into outputs. The inputs which are utilized during the process are referred to as factors of production (Debertin 2012). Production is not just a process of creating commodities but also includes other activities such as storage, packaging as well as transportation of the end products (Ekanem and Iyoha 1999).

2.2.3 Yield

Yield refers to the amount of agricultural produce that can be produced in a given area over a specified period. Yield can be measured in different ways such as the weight of the crop per unit area or as a % of the potential maximum production under certain conditions (Hayes, 2022)

2.2.4 Dietary Diversity

A person's dietary diversity refers to the range of foods or food types they eat. Dietary diversity is a useful metric for evaluating the nutritional value or sufficiency of diets that represent a range of food sources. Vitamins, minerals, nutrients, and phytochemicals must differ between the diets. Researchers measure dietary diversity as an indicator of diet quality for supporting nutrition and health. Eating a variety of foods can help one obtain different vitamins, minerals, nutrients, and photochemical that can help prevent nutrient deficiencies and chronic illnesses. Increased food security and a higher socioeconomic standing are correlated with more dietary diversity. In agricultural communities, there is a relationship between dietary diversity and biodiversity (Ahmed S, 2015)

2.2.5 Pfumvudza Concept

Pfumvudza signifies the start of a new farming season and it is the blooming of fresh leaves in the spring ((Mujere, 2022). A conservation agricultural method known as "pfumvudza" was created by the Foundation for Farming (FfF), a regional non-governmental organization in the nation. Smallholder farmers in Zimbabwe employ pfumvudza, a conservation-oriented agricultural technique. The Zimbabwean government introduced Pfumvudza in June 2020 (Mujere, 2021) , as a way of tackling food insecurity using conservation agriculture practices and also resilience towards smallholder farmers who are located in drought-prone areas(FAO 2013;2020;Lipper et al.,2014). Pfumvudza is based on three principles which are minimum tillage, intercropping cover crops with main crops and crop rotations.

Pfumvudza is practisedon a rectangular plot measuring 16m by 39m representing 0.06 ha. Three maize seeds are placed in each of the 1 456 planting stations that are in the plot. Each of the 52 planting rows has 28 planting stations which hold 2 maize plants. Interrow spacing is 75cm and in-row spacing across the slope is 60cm. the dimensions of each planting station must 15cm long, 15cm deep and 15cm wide.56 maize cobs weighing 300g on average are expected to be harvested from the 56 maize plants in each row. This will yield a 20 kg pail of shelled maize,

which can then be used to make enough mealie meal to last a week for a household of six. This suggests that a family of six may be fed for 52 weeks or a year by the 52 grain buckets from 52 plant rows. An appropriately managed plot should yield about 1 tonne of grain maize, or 15 t/ha.

Conservation agriculture practices such as pfumvudza can improve food accessibility by reducing input costs and generating household income through selling the end products. Few amounts of fertilizers, pesticides, seeds and labour are required when practisingpfumvudza making it more efficient than conventional agricultural practices hence lowering production costs to smallholder farmers. Farmers can trade their surplus yield in local markets thereby increasing their household income.

2.3 Challenges being faced when implementing conservation agriculture in developing countries

2.3.1Unaccessibility of Inputs

Adopting conservation agriculture often requires access to specific inputs such as cover crops, no-till equipment, and crop residues. The high cost of these inputs can significantly hinder the adoption of conservation agriculture among smallholder farmers. Von Loeper et al. (2016) highlight that the financial constraints faced by smallholder farmers in South Africa similarly affect their ability to invest in the necessary inputs for conservation agriculture. The situation is exacerbated in areas where farmers already struggle with limited financial resources and lack of access to credit facilities. Chinseu, Dougill, and Stringer (2019) further emphasize that the unavailability of these essential inputs can lead to dis-adoption of conservation agriculture practices, as farmers revert to traditional methods that require fewer resources. Therefore, ensuring accessibility and affordability of inputs is crucial for the successful implementation of conservation agriculture.

2.3.2 High Cost of Inputs

Smallholder farmers often find it prohibitively expensive to purchase or rent the specialized equipment required for conservation agriculture, such as cover crop seeders, no-till planters, and residue management tools. Brouder and Gomez-Macpherson (2014) argue that the high initial costs of these tools can deter farmers from adopting conservation agriculture, despite its long-term benefits. Additionally, the practice of mulching with crop residues, which is integral to

conservation agriculture, can incur significant costs for transportation and processing, particularly in regions where residue management is not commonly practiced (Scopel et al., 2013). The financial burden of acquiring these inputs is a substantial barrier, especially for resource-poor farmers who operate on tight margins and have limited access to financial support. Pannell, Llewellyn, and Corbeels (2014) also note that the economic feasibility of conservation agriculture at the farm level is a critical factor influencing its adoption.

2.3.3 Lack of Knowledge and Information

Farmers may lack a comprehensive understanding of conservation agriculture practices and their benefits, which is a significant barrier to adoption. Education and extension services are crucial for disseminating information and building capacity among farmers. Von Loeper et al. (2016) highlight the importance of providing adequate training and support to farmers to ensure they understand the principles and benefits of conservation agriculture. Chinseu, Dougill, and Stringer (2019) emphasize that without proper knowledge and information, farmers are likely to dis-adopt conservation agriculture practices due to perceived inefficiencies or challenges. Effective extension services play a vital role in addressing knowledge gaps and encouraging the adoption of sustainable agricultural practices. By enhancing farmers' understanding and skills, these services can significantly contribute to the successful implementation and sustainability of conservation agriculture.

2.3.4 Lack of Support

The successful implementation of conservation agriculture hinges significantly on the availability of assistance and training for farmers. Extension services, agronomists, and farmer-to-farmer knowledge exchange programs are crucial for providing the necessary support to ensure that conservation agriculture practices are adopted effectively. According to Von Loeper et al. (2016), extension services play a pivotal role in bridging the knowledge gap by offering technical advice, training, and continuous support to farmers. Additionally, Chinseu, Dougill, and Stringer (2019) stress the importance of agronomists and peer networks in facilitating the transfer of practical knowledge and skills. These support systems help farmers overcome initial challenges and adapt conservation practices to their specific contexts, enhancing the likelihood of successful adoption and sustained use of conservation agriculture.

2.3.5 Lack of Evidence

The widespread adoption of conservation agriculture is often hindered by insufficient scientific research and empirical studies that demonstrate its outcomes across different agroecological zones and farming systems. Many benefits of conservation agriculture, such as improved water retention and increased soil organic matter, take several years to fully manifest. Short-term studies may not capture these long-term benefits, leading to a perceived lack of evidence regarding its efficacy. Brouder and Gomez-Macpherson (2014) highlight the need for long-term studies to provide robust data on the impacts of conservation agriculture. Moreover, Scopel et al. (2013) emphasize that localized research is essential to understand how these practices perform under specific environmental and socio-economic conditions. Without comprehensive evidence, farmers and policymakers may remain skeptical about the benefits of conservation agriculture, thereby slowing its adoption.

2.3.6 High Labour Requirements

Some conservation agriculture practices, such as manual weeding or mulch application, can be labor-intensive and time-consuming, presenting a significant barrier to their adoption. In regions where labor is scarce and expensive, the high labor requirements of conservation agriculture can deter farmers from adopting these practices. Pannell, Llewellyn, and Corbeels (2014) note that the labor-intensive nature of certain conservation practices can make them less attractive, especially in areas where household members are engaged in multiple livelihood activities beyond agriculture. The competition for labor between agricultural and non-agricultural activities can further exacerbate the challenge of adopting conservation agriculture. Chinseu, Dougill, and Stringer (2019) also point out that the labor demands of conservation agriculture may compete with other essential activities, making it difficult for farmers to commit the necessary time and effort. This underscores the need for innovations and support systems that can reduce the labor burden and make conservation agriculture more feasible for smallholder farmers.

2.4 Effects of conservation agriculture on crop yields in developing countries

The Pfumvudza program has demonstrated significant potential in enhancing crop yields, a critical outcome for smallholder farmers in developing countries. Studies have shown that Pfumvudza can lead to substantial increases in crop productivity. For instance, Chikomo (2020) reported a 66% increase in maize yields and a 50% increase in sorghum yields compared to traditional farming methods. Similarly, Moyo (2021) found that legume yields increased by 40% under the Pfumvudza system. These improvements highlight the effectiveness of conservation agriculture in boosting agricultural productivity and ensuring food security.

Pfumvudza contributes significantly to food security by increasing crop yields and diversifying crop production. The Food and Agriculture Organization (FAO, 2020) indicated that the Pfumvudza program tripled yields compared to conventional methods. This increase in productivity ensures a more stable and abundant food supply, addressing the critical issue of food availability. By growing staple crops such as maize, millet, and sorghum, which are essential for the nutritional intake of Zimbabweans, Pfumvudza plays a vital role in enhancing dietary diversity and food security (Chikowo, 2020; Moyo, 2020; Nyagumbo, 2020).

The Pfumvudza program enhances resilience to climate variability, reducing the risk of crop failure due to adverse weather conditions. According to the International Maize and Wheat Improvement Center (CIMMYT, 2021), farmers adopting Pfumvudza experienced higher yields and reduced risks of crop failure caused by droughts. By improving soil health and water retention, Pfumvudza mitigates the impacts of climate change, providing a more reliable agricultural system. This resilience is crucial for smallholder farmers who face increasing climate challenges.

Effective use of agricultural inputs is another significant benefit of Pfumvudza. The program emphasizes practices such as full mulch coverage, proper fertilizer application, timely planting, and optimal crop spacing. As reported by Mujere (2022), farmers who adhered to these recommended practices achieved yields up to 800% higher than those using conventional methods. This efficient use of inputs not only enhances productivity but also promotes sustainable farming practices that are vital for long-term agricultural success.

Despite its potential benefits, the success of Pfumvudza can vary based on several factors such as labor constraints, extension support, and environmental conditions. Some studies have reported less favorable outcomes. Chikwati (2021) found that only 23% of farmers achieved the targeted maize yield of 1 tonne per plot during the 2019/2020 season. Similarly, Nyamadzawo (2021) observed a 12% reduction in maize yields compared to conventional practices due to inadequate rainfall and pest infestations. These findings underscore the need for adequate support and adaptation to local conditions to maximize the benefits of Pfumvudza.

2.5 Factors Affecting Dietary Diversity

2.5.1 Food Availability

The availability of diverse foods in marketplaces can also impact dietary diversity (Chinseu et al., 2019; Scopel et al., 2013). Rural areas often have less access to a wider variety of foods than urban areas (Brouder & Gomez-Macpherson, 2014). Availability of food seasonally and geographically can affect dietary diversity as certain foods may not be available in some places or during certain times of the year, even if individuals have the financial means to purchase them (Pannell et al., 2014; Von Loeper et al., 2016).

2.5.2 Food Preferences

Tastes and preferences significantly affect dietary diversity (Chikomo, 2020; Nyagumbo, 2020). The texture and appearance of food influence dietary choices, with individuals more inclined to consume foods that feel and look appealing to them (FAO, 2024; Mujere, 2022). Fear of trying new foods and negative experiences with specific foods can lead to restrictions in dietary diversity (CIMMYT, 2021; Moyo, 2021).

2.5.3 Geographic Location

Access to diverse foods varies across geographic locations, impacting dietary diversity (Government of Zimbabwe, 2021; Mugwira, 2020). Coastal areas often have greater access to diverse seafood, while inland regions rely more on agricultural products (Chinseu et al., 2019; Scopel et al., 2013). Urban areas typically offer a wider variety of foods compared to rural locations, where people often rely heavily on staple foods due to limited access to diverse options (Nyamadzawo, 2020; Nyamadzawo, 2021).

2.5.4 Time to Prepare Meals

Limited time for meal preparation can hinder dietary diversity (Chikwati, 2021; Chinseu et al., 2019). Conversely, having more time to prepare meals allows for exploration of a wider range of recipes and ingredients, promoting dietary diversity (Brouder & Gomez-Macpherson, 2014; Scopel et al., 2013). Time constraints in households where multiple members contribute to food preparation can also influence overall dietary diversity (FAO, 2020; Von Loeper et al., 2016).

2.5.5 Nutrition Knowledge

Individuals with a deep understanding of nutrition are more likely to prioritize dietary diversity (Pannell et al., 2014; Brouder & Gomez-Macpherson, 2014). Knowledge of the nutritional content of foods influences food choices, with those aware of nutrient-dense options incorporating a wider variety of foods into their diets (Von Loeper et al., 2016; FAO, 2024). Awareness of the risks associated with limited food choices motivates individuals to seek a diverse diet (Mugwira, 2020; Nyamadzawo, 2021). Nutrition knowledge empowers individuals to make informed decisions about food preparation methods and ingredients, promoting healthier and more diverse meals (Mujere, 2022; Chinseu et al., 2019).

2.5.6 Culture

Cultural traditions and customs significantly shape food consumption patterns and preferences, thereby impacting dietary diversity (Scopel et al., 2013; Brouder & Gomez-Macpherson, 2014). Beliefs and taboos dictate acceptable and desirable foods, influencing dietary choices (Chinseu et al., 2019; Nyagumbo, 2020). Different cultures possess unique cooking techniques, recipes, and dietary guidelines, affecting the variety of consumed foods (Chikomo, 2020; CIMMYT, 2021). Cultural attitudes towards food and health influence individuals' food choices and dietary diversity, with cultural events often contributing to dietary variety (Nyamadzawo, 2020; Government of Zimbabwe, 2021).

2.5.7 Seasonality

The seasonality of agricultural products impacts dietary diversity as certain foods become more expensive or scarce during off-season periods (Chinseu et al., 2019; Scopel et al., 2013).

Fluctuations in the availability and cost of foods throughout the year influence dietary diversity, with some products becoming inaccessible due to high prices (Nyamadzawo, 2021; FAO, 2020).

2.5.8 Income

Income plays a crucial role in determining dietary diversity (Pannell et al., 2014; Von Loeper et al., 2016). Individuals with higher incomes can afford a wider range of foods, including fruits, vegetables, and animal-based protein sources (Mugwira, 2020; FAO, 2024). Wealthier individuals have greater purchasing power, allowing them to modify agro-biodiversity by investing in diverse seeds, agricultural inputs, and land for crop cultivation (Chikomo, 2020; Nyagumbo, 2020).

2.5.9 Health Status

Individuals with specific health conditions or dietary restrictions, such as allergies or intolerances, may have a limited range of food choices, thereby impacting dietary diversity (Chinseu et al., 2019; Brouder & Gomez-Macpherson, 2014). Certain health conditions necessitate dietary modifications, leading to reduced dietary variety (Von Loeper et al., 2016; FAO, 2024). Nutritional needs vary across different life stages, such as pregnancy, infancy, lactation, and old age, requiring a diverse diet to meet increased nutrient demands (Scopel et al., 2013; Nyagumbo, 2020). Medications can interfere with nutrient absorption, prompting individuals to consume a more diverse diet to compensate for nutrient deficiencies (Chikomo, 2020; CIMMYT, 2021). During periods of illness or recovery, appetite and food intake may change, affecting dietary diversity, with certain foods being recommended or avoided based on health considerations (Nyamadzawo, 2021; Government of Zimbabwe, 2021).

2.6 Summary

The literature review highlights various challenges related to agricultural practices and dietary diversity. Challenges include limited access to diverse foods in rural areas, influenced by factors such as geographic location, seasonal availability, and economic constraints. Additionally, factors like food preferences, time constraints, and cultural norms play roles in shaping dietary diversity. However, conservation agriculture emerges as a promising solution, contributing

positively to crop yields and food security. Studies indicate significant increases in yields of staple crops like maize, sorghum, and legumes through conservation agriculture practices such as Pfumvudza, ultimately enhancing food availability and dietary diversity.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Brief description of study area

The study was conducted in Bindura District located about 16km east of Bindura town in Mashonaland Central Province which is located far on the North East part of Harare. Ward 13 lies under the agroecological region 2A while some areas in Bindura District are under region 2B. Annual rainfall in Region 2A ranges from a minimum of 750mm to a maximum of 1000mm per year and has an altitude of 1199mm. Natural region 2b has an average annual temperature 26^0C. Bindura District is characterized by savannah vegetation which has scattered trees in the grasslands. The area has different types of soils which include heavy clay, sandy soils and loamy soils. The Bindura District consists of small-scale and large-scale commercial farmers. The most commonly grown crops in the province include maize, groundnuts, groundnuts, cowpeas, wheat, , sugar beans, soya beans, tobacco and finger millet. Farmers in the district also keep livestock which include cattle, goats, sheep, pigs and poultry among others.

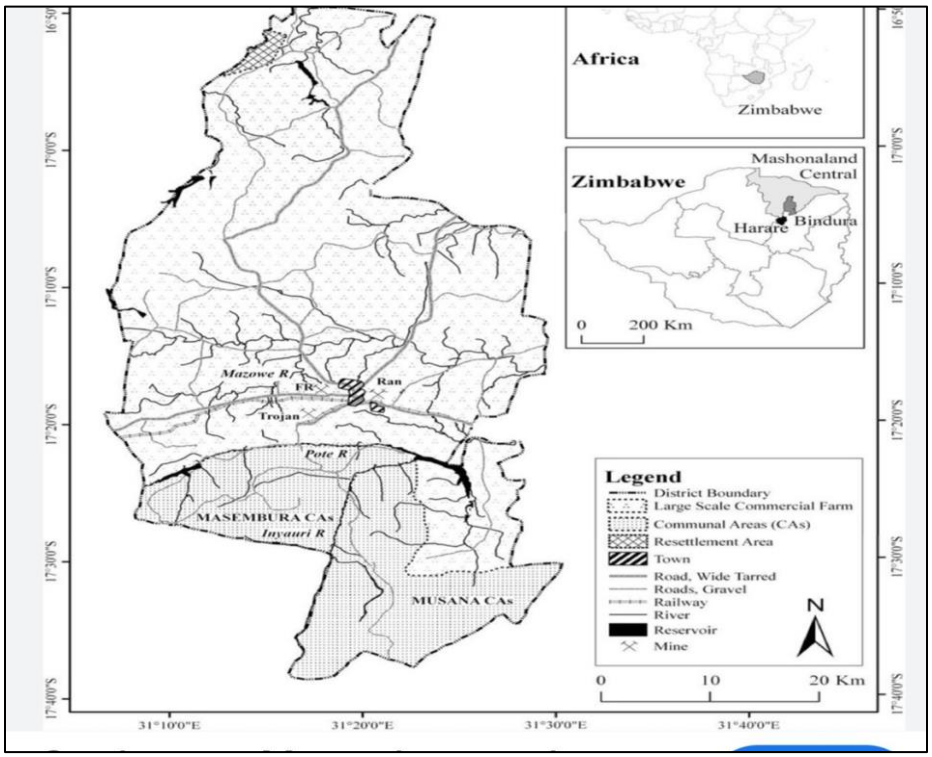

Fig 1. *Map of Bindura District*

4.3 Research design

The study used a descriptive case study research design which allowed the researcher to describe and provide a picture for the current situation. The descriptive case study research design was used in cooperationwith a mixed-method approach.A mixed-method approach combines both quantitative and qualitative methods to get a more comprehensive understanding of the research topic. Mixing datasets through a mixed method approach can result in triangulation which strengthens findings and allows for investigation from both inductive and deductive perspectives enabling researchers to combine theory generation and hypothesis testing within a single study (Jogulu and Pansiri 2011)

3.3 Sampling procedure

Due to lack of funding only a sample from Bindura district was used. Bindura District was selected using random sampling. To collect data that was necessary and valid both qualitative and quantitative data were collected from both primary and secondary sources to ensure reliability of results. The research was conducted in Ward 13 of Bindura District specifically in villages 1 and 2 where the pfumvudza program is being carried out. Purposive sampling was used to select the villagers. Purposive sampling involves selecting key informant respondents who have knowledge of the researcher's judgment (Babbie 2016). Some individuals have in-depth knowledge about the subject to be studied and on numerous occasions purposive sampling is used to select such individuals who are knowledgeable or experience a phenomenon of interest. Three key informants were targeted for interviews and these were the Bindura District Agronomist, District Agriculture Extension Officer and The Councillor for Ward 13.. The household heads that practiced pfumvudza in Ward 13 were targeted because they were the ones involved in implementing the resilience strategy. Household heads who were non-participants of pfumvudza were used as a control group which enabled the researcher to compare the level of production of the participants and non-participants to see if pfumvudza was effective or not. The sample size chosen was 20% of the target population resulting in 2 villages being chosen. A sample size of 20% was chosen to improve validity as supported by Crouch (2001) that a sample size of 20% improves the validity of the results (Crouch, 2001).

Convenience sampling was used to select the 2 villages that benefited from pfumvudza since working with all 9 villages was impossible as it gives a very big sample size. The two villages were conveniently selected because of their being easily accessible to respondents, geographical vicinity, availability at the given time and preparedness to take part in the research. As a result,Chiveso and Mazarura villages were chosen. Simple random sampling was utilized for the selection of household heads practicing pfumvudza in the two selected villages. Additionally, the participants were selected to participate in the study based on their willingness to communicate their views towards CA. A sample size of 20 % of the target population was used to participate in the study. 100% of household heads who practiced conventional farming were utilized to improve the validity of results. A purposive sampling technique was used to select key informants for the interview.

3.4 Data collection procedure

Structured Questionnaire

Questionnaires emerged as a pivotal tool for data collection, facilitating the comprehensive gathering of quantitative insights from a diverse range of smallholder farmers engaged in conservation agriculture as well as those not involved in such practices. The structured nature of questionnaires enabled researchers to systematically capture crucial information on various aspects including farming techniques, productivity metrics, dietary habits, and the perceived impact of conservation agriculture on food security and livelihoods. This method's strength lies in its ability to efficiently collect data from a large sample size, ensuring a representative understanding of the practices and perceptions prevalent among smallholder farmers in Zimbabwe. Moreover, the questionnaire design prioritized relevance to the study's objectives, ensuring that key variables such as farming practices and dietary diversity were comprehensively addressed. The quantitative nature of the data obtained through questionnaires enhances the study's analytical rigor and facilitates statistical analysis to discern patterns and correlations within the dataset, thus bolstering the validity and reliability of the study findings. Additionally, the inclusion of questions pertaining to farmers' perceptions offers valuable insights into the socio-economic dynamics shaping the adoption and outcomes of conservation agriculture practices, thereby enriching the study's relevance and contextual understanding of the subject matter.

Key Informant Interviews

Key informant interviews were employed as an additional method to augment the study's understanding of the socio-economic landscape and intricate dynamics surrounding conservation agriculture in Zimbabwe. By engaging with key stakeholders such as agricultural extension officers, local leaders, and agronomists, qualitative insights were gleaned concerning policy frameworks, community-level challenges, and the efficacy of support structures available to smallholder farmers. The strength of key informant interviews lies in their capacity to provide nuanced and contextually rich information, shedding light on the multifaceted dimensions of conservation agriculture practices. Moreover, these interviews offered valuable perspectives on the practical implementation of agricultural policies and the interaction between external interventions and local farming communities, thereby enriching the study's depth and relevance to real-world contexts.

Observations

Observations served as a complementary approach to triangulate findings obtained from questionnaires and interviews, offering direct and unfiltered insights into the actual farming practices and environmental conditions prevalent in smallholder farming communities. Through systematic field observations, researchers were able to validate self-reported data, identify discrepancies, and discern subtle nuances in agricultural techniques and resource management strategies. Additionally, observations facilitated a real-time assessment of the adoption and adherence to conservation agriculture principles, providing a holistic perspective on the challenges and opportunities encountered by farmers on the ground. By capturing contextual factors influencing agricultural productivity and dietary diversity, observations enhanced the study's credibility and provided a comprehensive understanding of the interplay between conservation agriculture and food security at the grassroots level.

3.5 Data analysis

With the use of Microsoft Excel and the Statistical Package for the Social Sciences (SPSS), quantitative data collected through closed-ended questionnaires was coded and examined. The data was presented in the form of tables, pie charts and graphs. Qualitative data obtained from open-ended questions, observations and interviews were analyzed using content analysisFor the

first objective which is to determine the challenges being faced in the implementation of conservation agriculture in Bindura District, descriptive statistics was used to rank the challenges being faced by farmers.For the second objective which is to investigate if maize yields vary across CA practicing and non practicing farmers in Bindura, ANOVA was used for comparing the farmers' yields since the data was obtained from secondary sources. ANOVA was used to test if there is a significant difference in household yields for farmers practicing against those not practicing conservation agriculture in Chiveso and Mazarura, Ward 13 Bindura District and also to analyze the difference in trend yields of those who implemented pfumvudza and those who did not. The tests were done at a 0.05 confidence interval. The level of significance was fixed at 0.05 ($p=0.05$). The third objective is to assess if dietary diversity varies amongst CA practicing farmers and non practicing farmers. To analyze the data Household Dietary Diversity Score was used to measure the dietary diversity of the farmers who volunteered to participate in the study.

Household Dietary Diversity Score

The Household Dietary Diversity Score (HDDS) is a widely used metric in assessing dietary diversity within households. It measures the variety of foods consumed by household members over a specified period, typically the preceding 24 hours. The HDDS is calculated based on the number of distinct food groups consumed by the household during this timeframe. These food groups are often defined by international guidelines, such as those outlined by the Food and Agriculture Organization (FAO) or the World Health Organization (WHO). Commonly included food groups range from staples like grains, tubers, and legumes, to fruits, vegetables, dairy products, meats, and fish. Each food group consumed by the household contributes to a higher score on the HDDS, reflecting greater dietary diversity.

The HDDS is typically calculated by assigning a score of '1' to each food group consumed by the household within the specified period. The total score is then the sum of these individual scores across all food groups, providing a quantitative measure of dietary diversity. Higher scores on the HDDS indicate a more diverse household diet, suggesting greater access to a variety of foods and, by extension, better nutritional intake. In terms of interpretation, a higher HDDS is often associated with improved food security within the household, as it indicates a broader range of available food options. The score range for HDDS varies depending on the number of food groups included in the assessment, but generally, a higher score signifies a more diverse and

nutritionally adequate diet, while a lower score may indicate limited dietary variety and potential nutritional deficiencies.

3.6 Ethical Considerations

Ethical considerations for the study were paramount and adhered to throughout the research process. Informed consent was obtained from all participants, ensuring their voluntary participation and understanding of the study's objectives, procedures, and potential risks. Confidentiality of participant information was rigorously maintained, with data anonymized to protect the identities of individuals involved. Additionally, efforts were made to minimize any potential harm or discomfort to participants during data collection, ensuring respectful and non-intrusive interactions. The research protocol was reviewed and approved by the relevant ethical review board, ensuring compliance with ethical guidelines and standards. Overall, the study upheld ethical principles of respect, beneficence, justice, and integrity, safeguarding the rights and well-being of all involved stakeholders.

3.7 Chapter summary

The research design employed in this study is descriptive, utilizing a mixed methods approach to gather comprehensive data on the impact of conservation agriculture on crop yields and household food security in Zimbabwe. Purposive sampling was employed to select smallholder farmers practicing conservation agriculture as well as those not practicing, ensuring a diverse representation of perspectives. Data collection involved the use of questionnaires, key informant interviews, and observations to gather both quantitative and qualitative data on farming practices, productivity levels, dietary diversity, and perceptions of conservation agriculture's impact. The quantitative data collected through questionnaires were analyzed using statistical techniques, while qualitative data from key informant interviews and observations were analyzed thematically to identify patterns, trends, and contextual factors influencing agricultural outcomes. This mixed methods approach allowed for a comprehensive understanding of the research topic, integrating both numerical data and rich contextual insights to inform the study findings.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

All the investigations carried out during this study are presented in this chapter. Quantitative information is presented visually using pie charts and qualitative data is presented using tabular presentations. The findings of this project are analyzed and presented to the reader.

4.2 Response rate analysis

Questionnaire response rate analysis

Table 4. 1 Questionnaire Response Rate

Number administered	Responded	Not responded	Response rate	Non-response rate
100	80	20	80	20

The table above shows the response rate for this study.

4.3 Household demographic characteristics

4.3.1 Descriptive Demographic Characteristics

The results indicate data pertaining to four variables: Income, Household Size, Experience, and Size of Land, derived from a sample size of 80 respondents. For the Income variable, the minimum reported income was $124, while the maximum reported income was $5123.1, with a mean income of $711.78 and a standard deviation of $12.723, reflecting the spread or variability of income among the respondents. In terms of Household Size, the minimum reported size was 2 members, while the maximum was 10 members, with a mean household size of 4.64 members and a standard deviation of 1.981, suggesting the diversity in household compositions within the sample. The Experience variable ranges from a minimum of 0.3 years to a maximum of 23 years, with a mean experience of 9.21 years and a notably high standard deviation of 2673, indicating considerable variability or dispersion in the reported years of experience. Lastly, the Size of Land variable ranges from 0.5 acres to 8 acres, with a mean land size of 7.31 acres and a standard deviation of 1.165, suggesting relatively consistent land sizes among the respondents, albeit with some degree of variability. These descriptive statistics provide insights into the

distribution and characteristics of the variables within the sample population, aiding in the interpretation and understanding of the study results.

Table 4. 2 Descriptive household characteristics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Income	80	124	5123.1	711.78	12.723
household size	80	2	10	4.64	1.981
Experience	80	0.3	23	9.21	2673
Size of Land	80	0.5	8	7.31	1.165
Age	80	19	78	34.5	5.716

4.3.2 Gender

The study consisted of 51% men and 49% females as represented by the pie chart below. This shows female dominance in Pfumvudza. This is because women are dominant in food security activities which part of their household roles. This is different from the findings ofVon Loeper et al., (2016)who found male as dominant in agriculture activities due to their drudgery nature.

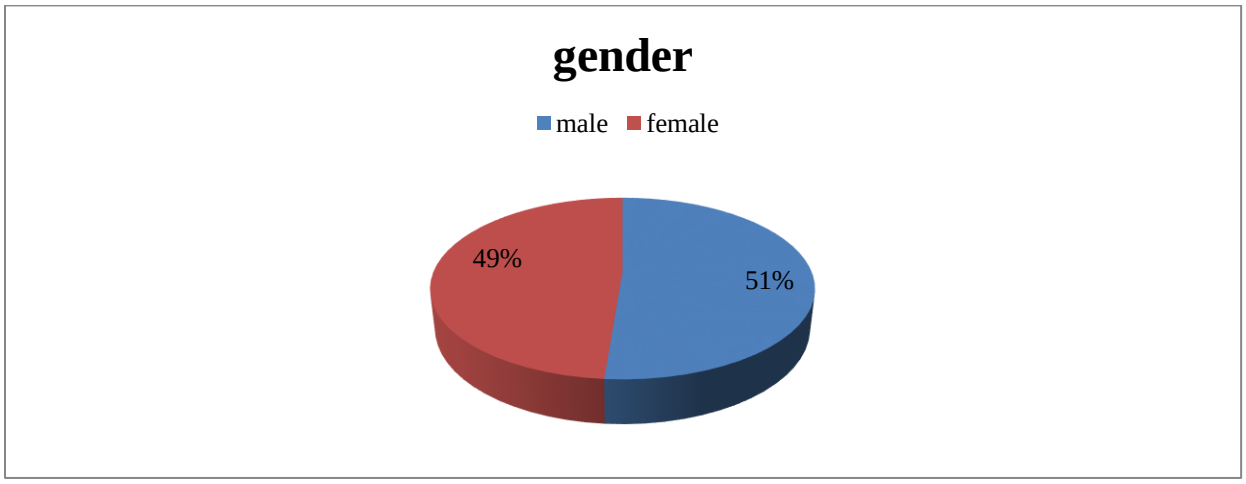

Figure 4. 1 Gender distribution of respondents

4.2.3 Source of labour

The most (49%) of the study partcipants are working as a group which can be called a cooperative astheir source of labour being used when practicing CA while 28% of the labour

being used for CA is from family, 16% is hired labour and 7%of the labour is from employees. This can be shownin the pie chart below;

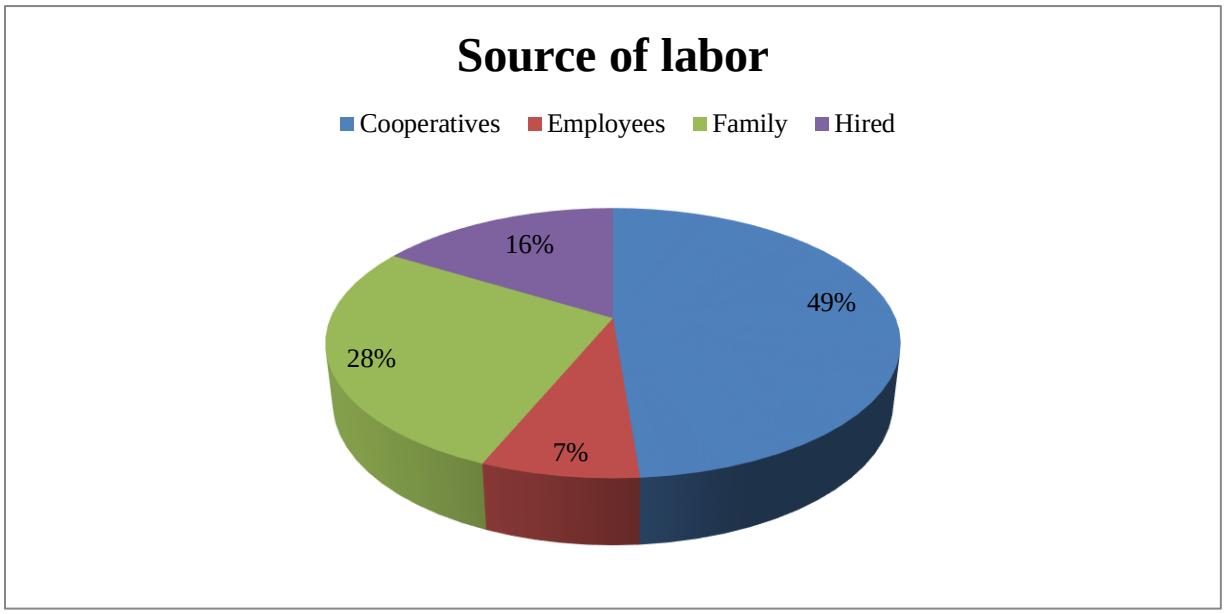

Figure 4. 2 Source of Labour

4.3.4 Educational level

In Bindura district, most farmers went up to the secondary level with a percentage of 34%. A percentage of 22% of farmers went up to tertiary, 15% of the farmers went up to primary level and a percentage of 29% resorted to informal education. This can be shown in the pie chart below;

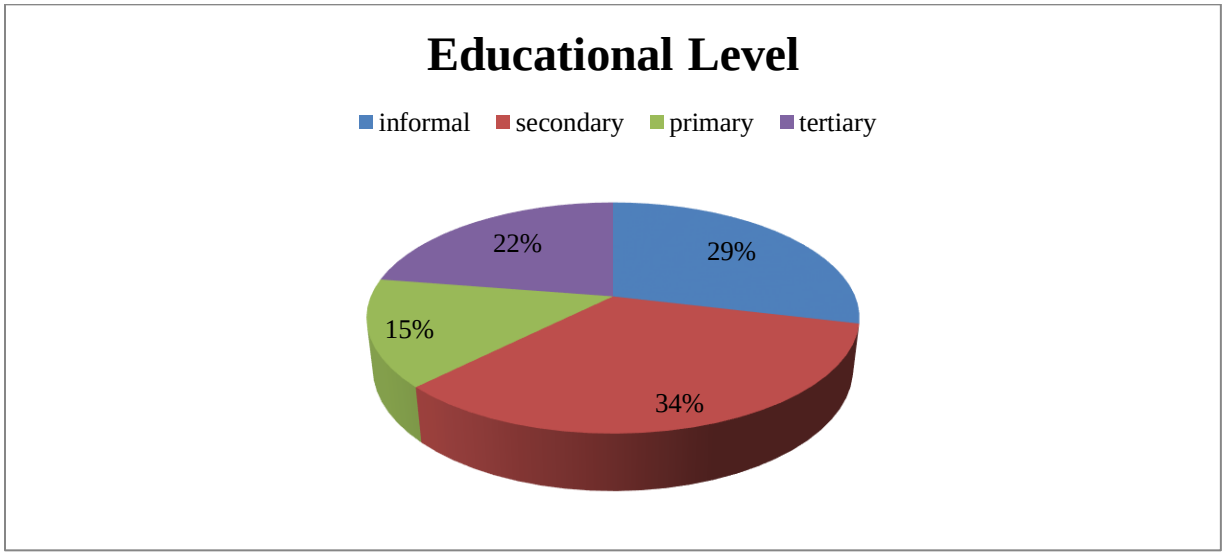

Figure 4. 3 Educational Qualifications of respondents

4.3.5 Smallholder farmer practices

Figure 4.4 shows that 87% of the farmers in the study are practicing conservation agriculture. A remainder of 13% is the few smallholder farmers not practicing conservation agriculture. This shows that the majority of the farmers are into CA and according to (Von Loeper et al., 2016) this is due to government Pfumvudza program which was rolled nationwide.

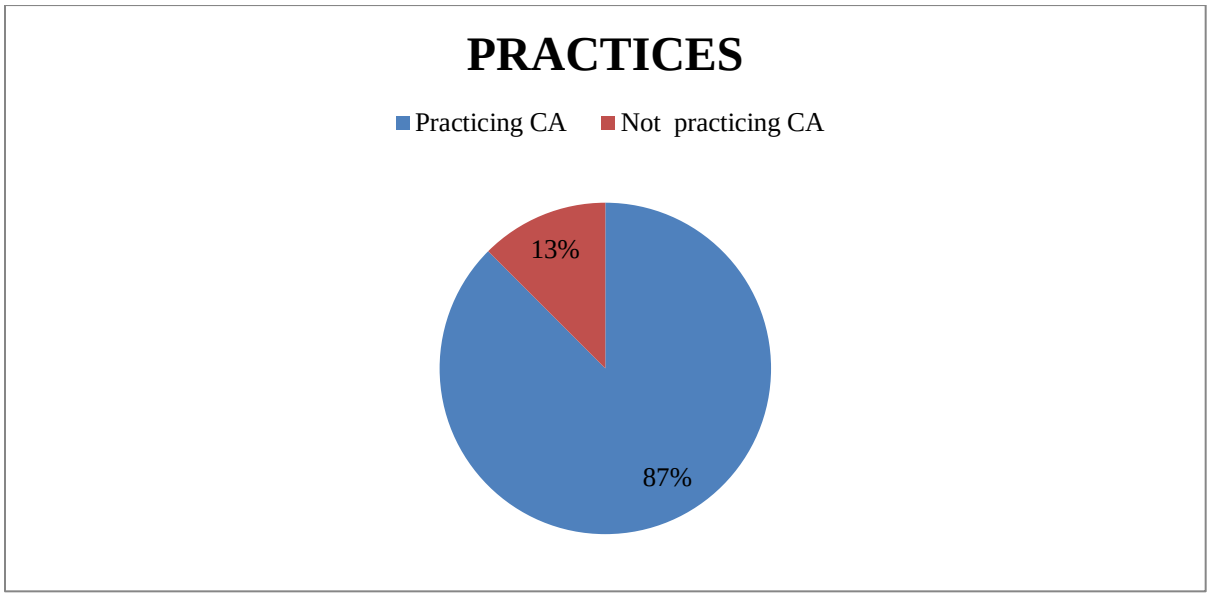

Figure 4. 4 Distribution of farmer conservation agriculture practices

4.4 Challenges being faced in the implementation of conservation agriculture practices

Table 4. 3 Challenges faced in the implementation of conservation agriculture

Challenge	N	Mean Score	Std. Deviation
uneven distribution	80	3.45	1.272
shortage of inputs	80	3.01	1.41
lackofevidence	80	3.23	1.396
untimelydistributionofinputs	80	4.56	1.004

labour shortages	80	3.21	1.198
pests and diseases	80	4.47	1.006
limited security	80	3.06	1.399

Untimely distribution of inputs is one of the most severe challenge in the successful implementation of conservation agriculture. This challenge, reflected by a high mean score of 4.56 and a low standard deviation of 1.004, indicates the logistical hurdles associated with ensuring timely access to seeds, fertilizers, and other inputs. Delays or disruptions in input distribution can disrupt farming schedules and compromise agricultural productivity, particularly during critical planting periods (Scopel et al., 2013).

This is followed in terms of severity by Pest and disease pressures which pose a constant threat to agricultural productivity, especially in conservation agriculture systems. Indicated by a high mean score of 4.47 and a low standard deviation of 1.006, this challenge highlights the vulnerability of crops to biotic stresses. Integrated pest management strategies are essential to mitigate the risks associated with pests and diseases, ensuring sustainable crop production and livelihood security for smallholder farmers (Brouder & Gomez-Macpherson, 2014).

This is followed by the uneven distribution of resources among smallholder farmers. This challenge, as indicated by a mean score of 3.45 and a standard deviation of 1.272, reflects disparities in access to inputs, extension services, and support mechanisms. Such inequalities can exacerbate existing socio-economic disparities among farmers, hindering the widespread adoption of conservation agriculture practices (Von Loeper et al., 2016).

The lack of evidence supporting the efficacy of conservation agriculture interventions poses a significant challenge to adoption. With a mean score of 3.23 and a standard deviation of 1.396, this challenge underscores the importance of empirical research and data-driven assessments to validate the benefits of conservation agriculture. Without robust evidence demonstrating its effectiveness, farmers may be hesitant to invest time and resources in adopting new agricultural practices (Chinseu et al., 2019).

Labour shortages present a significant obstacle to the adoption of conservation agriculture practices. With a mean score of 3.21 and a standard deviation of 1.198, this challenge

underscores the importance of adequate human resources for implementing labor-intensive activities such as mulching and weeding. In regions where there is a shortage of farm labor or competing livelihood activities, farmers may struggle to allocate sufficient labor to conservation agriculture practices, affecting their adoption and effectiveness (Pannell et al., 2014).

The second least severe challenge in the study is the issue of limited security, encompassing concerns related to land tenure, property rights, and social stability, presents a significant barrier to the adoption of conservation agriculture. With a mean score of 3.06 and a standard deviation of 1.399, this challenge reflects broader socio-political dynamics that can undermine farmers' willingness to invest in long-term agricultural practices. Insecure land tenure and property rights can discourage farmers from making investments in conservation agriculture, fearing the risk of losing their land or facing disputes over ownership (Von Loeper et al., 2016).

The least severe challenge identified is the shortage of inputs required for conservation agriculture practices. With a mean score of 3.01 and a standard deviation of 1.41, this challenge highlights the limited availability of essential resources such as seeds, fertilizers, and equipment. The scarcity of inputs can impede farmers' ability to transition to conservation agriculture, particularly in resource-constrained environments where access to agricultural inputs is limited (Brouder & Gomez-Macpherson, 2014).

4.5 Comparison ofthe yields for farmers practicing CA and those not practicing CA

4.5.1 Yield Comparison

Table 4.4 illustrates a comparative analysis of average yields between farmers practicing conservation agriculture (CA) and those not engaging in CA practices. Farmers practicing CA demonstrated a notably higher average yield of 3.08tonnes/ha, in contrast to non-CA farmers, who yielded an average of 2.49tonnes/ha. The overall average yield for both groups combined was 3.01tonnes/ha. These findings suggest that conservation agriculture practices positively influence agricultural productivity, leading to higher yields among CA practitioners. This aligns with existing literature emphasizing the beneficial impact of CA on crop yields, attributed to improved soil health, enhanced water retention, and reduced soil erosion (Brouder & Gomez-Macpherson, 2014). Additionally, CA practices promote sustainable agricultural systems, such as

reduced tillage and crop residue management, which contribute to increased productivity and resilience to environmental stressors (Pannell et al., 2014)

Table 4. 4 Yield Comparison between CA and non-CA farmers

PractisingornotpractisingCA	Average Yield±SD
Practicing	3.08±0.112
not practicing	2.49±1.094
Total	3.01±1.732

The ANOVA table (Table 4.5) presents the results of the analysis of variance for the effect of practicing conservation agriculture (CA) on crop yields. The table indicates that there is a significant difference in yields between farmers practicing CA and those not engaging in CA practices, as evidenced by a large F-value of 1.123 and a p-value of .003. This suggests that the variation in yields can be attributed to whether farmers practice CA or not. The sum of squares between groups (3.019) is considerably larger than the sum of squares within groups (209.710), indicating that the variance in yields is primarily due to differences between CA and non-CA farmers rather than variations within each group. These findings support the notion that conservation agriculture practices have a significant impact on crop yields, aligning with previous research emphasizing the positive influence of CA on agricultural productivity (Brouder & Gomez-Macpherson, 2014; Scopel et al., 2013)

Table 4. 5 ANOVA for mean yield of conservation agriculture practicing and non-practicing households.

		Sum of Squares	df	Mean Square	F	Sig.
Yield * PractisingornotpractisingCA	Between Groups (Combined)	3.019	1	3.019	1.123	.003
	Within Groups	209.710	78	2.689		
	Total	212.729	79			

4.5.2 Dietary diversity of farmers practicing CA and those not practicing

The comparison table illustrates the Household Dietary Diversity Scores (HDDS) between farmers practicing conservation agriculture (CA) and those not engaging in CA practices. The data reveals that households practicing CA exhibit a higher mean HDDS of 7.84 compared to non-CA households with a mean HDDS of 6.9. This disparity suggests that practicing conservation agriculture is associated with greater dietary diversity within households. The total mean HDDS across both groups is 7.73. These findings align with Von Loeper et al., (2016) who indicated that conservation agriculture interventions contribute positively to household dietary diversity by enhancing agricultural productivity and promoting the cultivation of a variety of crops.

Table 4. 6 Comparison of mean dietary diversity of farmers practicing CA and those not practicing

PractisingornotpractisingCA	HDDS
Practicing	7.84
not practicing	6.9
Total	7.73

The ANOVA findings in Table 4.7presents the analysis of variance for Household Dietary Diversity Scores (HDDS) between farmers practicing conservation agriculture (CA) and those not engaged in CA practices. The table indicates a statistically significant difference in HDDS between the two groups, as evidenced by an F-value of 2.807 and a significance level of .001. The between-groups variance (7.779) exceeds the within-groups variance (216.171), suggesting that the variation in HDDS is more pronounced between CA and non-CA households. This outcome underscores the impact of conservation agriculture on promoting greater dietary diversity within households, aligning with previous research from Von Loeper et al. (2016) who highlighted the positive association between CA adoption and improved dietary outcome since CA encourages crop diversification as well as crop cover for example legumes in maize field as green manuring.

Table 4. 7ANOVA for mean dietary diversity of conservation agriculture practicing and non-practicing households.

		Sum of Squares	df	Mean Square	F	Sig.
HDDS * Practisingornotpractising CA	Between Groups (Combined)	7.779	1	7.779	2.807	.001
	Within Groups	216.171	78	2.771		
	Total	223.950	79			

With an F value of 2.807 from the tested results it is concluded that there is a significant difference in the yields of farmers practicing CA and those not practicing CA

4.6 Conclusion

The research concluded that farmers who used conventional methods and relied on rain-fed agriculture had low yields due to the negative impacts of climate change. Farmers practisingconventional agriculture had a low household dietary diversity score which was induced by climate change-induced droughts which occurred very often in the ward.Farmers who practisedCA had an increase in yields compared to their counterparts who stuck to conventional agriculture. CA had a positive impact on crop yield. However, lower yields were still experienced by some farmers as they couldn't adhere to certain CA principles but when compared to their counterparts not practisingCA the yields were slightly higher. This showed that CA brought a change in yields increasing resilience to droughts and enhancing household dietary diversity since the farmers practicing CA also use other crops as cover, and also adhere to principles of crop diversification which increases the number of crops they grow.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The main objective of this chapter is to summarize the findings of the studyprovide a conclusion and recommendations on how to solve the problems being faced in the agricultural industry concerning the study's results.

5.2 Research summary

Conservation agriculture has been a useful tool for smallholder farmers in trying to be resilient towards climate change and attaining dietary diversity in Bindura district. the study used a mixed method approach in trying to investigate if there is productivity and dietary diversity for smallholder farmers practicing conservation agriculture. The study utilized a mixed approach which involved collection of quantitative and qualitative data using observations, research questionnaire and Key Informant interview. The study sample was 100 respondents although the final response rate was 80%. In addition to this random sampling was used to select the respondents for the study whereas purposive sampling was used to select the Key informants in the study. The study utilized ANOVA and mean score ranking as well as descriptive statistics such as means, percentages and standard deviation for analysis of the data collected.

Based on the study's findings, smallholder farmers who are practicing conservation agriculture in Bindura District are productive and are attaining dietary diversity more on smaller pieces of land as compared to their counterparts still practicing conventional agriculture. Maize which is the staple food in Zimbabwe is mostly produced, other crop varieties such as sweet potatoes, sugar beans, sorghum, finger millet and groundnuts are also being grown under CA to attain dietary diversity.

CA programs such as the pfumvudza program had a positive impact on soil health as it supported the use of organic fertilizers, crop rotation and minimal soil disturbance. These practices ensured a reduction in soil erosion and improved soil fertility which had been a problem for smallholder farmers before the introduction of CA practices in Bindura District.

The study found that CA practices increased the productivity of farmers in Bindura District and raised the household dietary diversity score for farmers practicing CA as it improved soil health, increased yields, reduced cost of inputs since it is practisedon small pieces of land and resilience to climatic changes.

There was an average yield of 600kg per plot under CA and 250kg for a plot where conventional agriculture was practised. This showed that if a household worked on 3 or more 0.0064-sized plots they could get enough food for a year and sell the surplus. CA also had a positive impact on the household dietary diversity score for smallholder farmers in Bindura District as they had an average score of 7 compared to the 3.8 of the smallholder farmers that were practicing conventional agriculture.

5.3 Conclusion

Conclusively, there is a need for the government to sponsor more in the training of smallholder farmers to adopt CA as it improves soil health, reduced erosion and there higher yields to be obtained from a small piece of land which is an advantage to farmers as they can get more from a low-cost investment.

5.4 Recommendations

Based on the findings of the study, the recommendations aim to promote conservation agriculture (CA) adoption and enhance its effectiveness in improving household dietary diversity and resilience:

- Financial Incentives for CA Adoption: Implement tax holidays or subsidies for companies supporting CA initiatives. This could include tax breaks for firms providing CA tools, inputs, and equipment, encouraging investment in sustainable agricultural practices.
- Capacity Building for Farmers: Prioritize capacity-building programs to educate smallholder farmers on the principles and benefits of CA. Training sessions, workshops, and extension services can enhance farmers' knowledge and skills in implementing CA techniques effectively.
- Promotion of Crop Diversification: Encourage farmers to diversify their crop production to minimize risks associated with monoculture and enhance household dietary diversity.

Extension services and farmer-to-farmer knowledge exchange programs can facilitate the adoption of diverse cropping systems under CA.

- Policy Support for CA: Advocate for supportive policies at the governmental level to promote CA adoption. This could involve providing rebates for importation of CA tools and inputs, along with policies that incentivize sustainable agricultural practices and conservation-oriented farming methods.
- Infrastructure Development: Invest in rural infrastructure to improve access to markets, agricultural extension services, and input supply chains for smallholder farmers practicing CA. Improved infrastructure can facilitate the adoption and scaling-up of CA initiatives, especially in remote and marginalized areas.
- Research and Knowledge Sharing: Foster collaborative research initiatives and knowledge-sharing platforms to generate evidence-based insights into the benefits and challenges of CA adoption. This can inform the development of targeted interventions and best practices for promoting CA among smallholder farmers.

By centering on these strategies, stakeholders can effectively promote CA adoption, enhance household dietary diversity, and build resilience among smallholder farmers, thereby contributing to sustainable agricultural development and food security.

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Annex 1: Household Questionnaire

My name is Jorum R Njanji a student at Bindura University of Education pursuing a BSc Honours Degree in Agricultural Economics and Management. I am carrying out a research on the investigation of productivity and dietary diversity of smallholder farmers practicing conservation agriculture in Bindura District. All information provided by the respondents will be kept **CONFIDENTIAL** and will serve no other purpose besides academic. Your co-operation is valuable in the process. Thank you for your assistance.

Enumerator name ……Name of respondent……

District name……Village Name……

Ward …… Date……

A. HOUSEHOLD DEMOGRAPHIC AND SOCIO=ECONOMIC INFORMATION					
1. Head of household					
a. Gender	Male		Female		
b. Age					
c. Marital status	Married	Single	Divorced	Widowed	
d. Level of education of any household member					
	No formal or informal education	Informal education	Primary	Secondary	Tertiary Education
2. What is your occupation?					
3. What is your religion	Christianity	Traditional	Muslim	Other (specify)	
		Adults(≥18)	Children (<18)		
4. What is the size of your household	Male				
	Female				

5. What are your sources of income (rank 1 as the most important source)		
Source	Monthly income	Rank
Crops		
Vegetables		
Livestock		
Poultry		
Salary		
Pension/grants		
Trade (transport, resale of goods)		
Sale of wild fruits		
Craftwork (mats, baskets, pots)		
Community projects		

Other (specify)						
6. Which of the following water source do you have access to in your village						
Tap	Stream/river	Tank	Dam	Borehole	Spring	Other (specify)

B. AGRICULTURE			
1. What agriculture activities do you practice?			
Livestock	Crop production	Vegetable farming	None
2. Who holds title for the land?			
Privately owned	Communal land	Lease agreement	Freehold
3. Would you agree that conservation agriculture has a positive effect on yields?			
Agree	Neutral	Disagree	
4. Which conservation agriculture techniques are you practicing, if you didn't practice any one of the techniques what was the reason? (Rank 1 as the most practiced)			
Technique	Rank	Reason for not practicing	
Winter weeding			
Application of mulch			
Digging of basins			
Application of manure			
Application of basal fertilizer			
Post planting timely weeding			
Application of top dressing			
Crop rotation			
Zero tillage			
Water harvesting			
Application of manure			

5. Which inputs are you using when farming? (Rank 1 as the most useful)	
Input	Rank
Seeds	
Fertilizer	
Herbicides	
Pesticides	
Machinery	
Fungicides	
Manure	
Other (Specify)	

6. What is your source of seeds and fertilizer? (Rank 1 as the common supplier)					
	Maize	Sugar beans	Sweet potatoes	Traditional grains	Fertilizer
NGO					
NGO from previous season					
Own stock					
GMB					

Local farmer					
Seed fair					
Presidential input scheme					
Other (specify)					

7. Which crops and vegetables did you grow last season? (Rank 1 as the most commonly grown crop/vegetable)				
Crop/vegetable	Rank 1 as the most planted	Area planted /ha	Amount consumed	Yield/ha
8. Are you practicing conservation agriculture?			Yes	No
9. IF (NO) why are you not adopting conservation agriculture?				

10. What is your motivation for practicing conservation agriculture? Rank 1 as the most common reason.	
Reason	Rank
Improved soil health	
Increased yields	
Long term sustainability	
Reduced farm management effort	
Environmental benefits	
Economic incentives	
Resilience to climate change	
Reduced input cost	
Access to knowledge and resources	

11. What is your motivation for practicing conventional agriculture? Rank 1 as the most common reason.	
Reason	Rank
Reliance on established practices	
Access to established markets and supply chains	
Perceived short term benefits	
Risk aversion	
Resource availability	
Financial considerations	
Technological dependence	
Influence of peer networks	

12. What do you consider to be the main problem in adopting CA? (Rank 1 as the worst problem)

Uneven distribution of rainfall			
Untimely distribution of inputs			
Pests and diseases			
High cost of inputs			
Poor quality inputs			
Shortage of inputs			
Lack of skills and knowledge			
Lack of support			
High labor requirements			
Lack of evidence			
Others (Specify)			

13. Are you receiving training/refresher courses in promoting conservation agriculture?			
14. What is your source of labor?			
Family	Employees	Hired labor	Other (specify)

C. HOUSEHOLD DIETARY DIVERSITY STATUS

1. What are your sources of food? (Rank 1 as the most important)			
Own production	Food at work	Gathering wild fruits	Own livestock products
Purchased	Fishing	Loans	Friends/relatives
Bartered	Hunting	Steal	Food at school
Food aid	Food for work	Stocks	Gifts of food
Other sources of food(specify)			
2. What types of foods did anyone in your household ate yesterday during the day and night at your home (didn't eat =0 and ate =1)			

Food Group	Examples	Didn't eat=0 Ate =1	
Cereals	Maize, rice, wheat, sorghum, millet or foods made from these products		
Tubers	White potatoes, white cassava		
Vitamin A rich vegetables	Pumpkin, carrot or sweet potatoes that are orange inside and red sweet pepper		
Dark green leafy vegetables	Dark green leafy vegetables such as cassava leaves and spinach		
Other vegetables	Tomatoes, onion and eggplant		
Vitamin A rich fruits	Ripe mangoes, apricots, dried peach 100% fruit juice		
Other fruits	Wild fruits		
Organ meat	Liver, kidney, heart or blood based foods		
Flesh meats	Beef, pork, lamb, goat, rabbits, game meat, chicken, duck, other birds and insects		
Eggs	Chicken eggs, duck eggs and guinea fowl eggs		
Fish and seafood	Fresh or dried fish and shellfish		

Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, or foods made from these e.g. peanut butter		
Milk and milk products	Milk, cheese, yogurt or other milk products		
Oils and fats	Oil, fats or butter added to food or used for cooking		
3. On average how many meals do you have per day?			
4. Do you think you have access to enough food		Yes	No
5. How do you rate your level of access to food nowadays as compared to last year?			
No change	Better	Fair	Worse off
6. What factors are affecting your dietary diversity status? (Rank)			

Food availability	
Food preferences	
Time to prepare	
Health status	
Income	
Seasonality	
Geographical location	
Nutritional Knowledge	
Culture	
Other (specify)	

15. What type of livestock do you keep?							
	Class	Cattle	Goats	Sheep	Chicken	Pigs	Other(Specify)
	Number						
	Rank						

16. Why do you keep livestock (Rank 1 as the most important)			
Use	Rank	Use	Rank
Draught power		Sale	
Milk		Status	
Meat		Dowry	
Skin		Ceremonies	
Other (Specify)			

Annex 2: Key Informant Guide

1. Can you tell me about your farming experience?
2. Are you practicing conservation or traditional agriculture?
3. Can you describe your experience with conservation agriculture practices?
4. How have they impacted your farming activities?
5. What crops do you typically grow?
6. What motivated you to adopt or not adopt conservation agriculture practices?
7. What challenges have you faced in implementing conservation agriculture practices?
8. How have you overcome the challenges faced in implementing conservation agriculture?
9. How do you think conservation agriculture has affected your crop yield?
10. How do you think conservation agriculture has affected your dietary diversity?
11. Are you able to grow a variety of staple crops, fruits and vegetables on your farm?
12. How has your access to different types of foods changed since you started practicing conservation agriculture?
13. Have you noticed any changes in your socio-economic status since dopting conservation agriculture practices?
14. How do you think conservation agriculture can be improved among smallholder farmers?
15. Can you share any success stories or lessons learned from your experience with conservation agriculture?

Annex 3: Observation Check List

Question number	Question	YES	NO
1	Is the farmer using conservation agriculture?		
2	Conservation agriculture practices		
	Minimum tillage		
	Permanent soil cover		
	Crop rotation		
	Use of cover crops		
	Digging of holes		
2	Does the arable land for each farmer exceed 0.06 ha?		
3	Are the farmers using pesticides, fertilizers or any other inputs?		
4	Is there a variety in crops being grown?		
5	Is the soil in conservation agriculture practicing farmers healthy than that of non practicing farmers?		
6	Is there use of external sources of water for irrigation?		
7	Is there a difference in pest and disease pressure between practicing and non practicing farmers.		
8	Are the farmers able to use methods of reducing soil erosion because of the steep terrain?		
9			
10	Do they own livestock to supplement their diet?		
	Are there differences in the yields between conservation agriculture practicing and non practicing farmers?		
11	Is there another source of feed for the farmers or they rely previous harvest reserves?		
12	Are the smallholder farmers food secure?		
13	Are the farmers eating a diverse diet or a limited diet?		

N.B: Tick the correct answer.

Annex 4: Informed Consent Form

Thank you for participating in this study. My aim is to investigate if conservation agriculture practices have an effect on productivity and dietary diversity amongst smallholder farmers. Your participation in this research will help me have a better understanding on the benefits and challenges of implementing conservation agriculture and inform strategies to imptove farming practices and nutrition

The purpose of the study is to collect data on your farming pratises, yields, dietary attributes and information to compare the productivity of conservation agriculture practicing and non practicing smallholder farmers.

Data will be collected through observing your farms and farming practices, household questionnaires and review of your farm records and documents

Your personal information and data will be kept confidential an anonymous. Your name and identity will not be linked to the data collected.

There are no anticipated risks or discomforts associated with the study

Your participation is voluntary and you may withdraw from the study at any time without loss of benefits or penalties.

Contact Information

If you have any queries, please contact Jorum R Njanji at jorumrufaronjanji@gmail.com or 0775 755 979

I ……., have read and understood the information above and consent for participating in this study. I understand that my participation is voluntary and I may withdraw anytime.

Signature…….

Date ……