Conservation Agriculture as an adaptation strategy to drought in Chivi District, Zimbabwe

By

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A research thesis submitted to the Department of Geography and Geo-Information Sciences in fulfilment of the requirements for the degree of Doctor of Philosophy (Geography) in the School of Environmental Sciences, University of Venda

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March 2020

DECLARATION

I, Jestina Chineka, hereby declare that this thesis submitted to the Department of Geography and Geo-Information Sciences for the award of the degree, Doctor of Philosophy in Environmental Sciences at the University of Venda, has not been previously submitted for a degree at this or any other institution. This is my work in design and execution, and all referenced materials contained herein have been duly acknowledged.

Signature ____________________ Date: 02 /09/2020

Jestina Chineka

DEDICATION

To all the farmers in dry lands, whose livelihoods solely depend on agriculture.

ACKNOWLEDGEMENTS

To God Almighty, all the glory belongs to you, and Ebenezer, thus far you have taken me. It was not an easy journey but your mercy and grace pushed me through. Thank you so much for awarding me such a valuable opportunity to study and guiding me throughout this research work.

"He who accepts to be rebuked, will have his place among the wise" (Proverbs 15:31). My outmost gratitude goes to my promoters, Prof Hector Chikoore and Dr Nthaduleni Samuel Nethengwe. It is through your effort in correcting this research work, that we have this document. Your patience, thorough supervision, support, encouragement and guidance led to the successful completion of this study. My sincere gratitude goes to the Research and Publications Committee of the University of Venda for the financial support during the research period. The support went a long way in enabling me to carry out data collection.

I acknowledge the support, cooperation and patience of the Chivi district administrator Mr Hlavati, Masvingo Provincial Agriculture Extension Officer Mr Poshai, Mr Mpofu from CARE International, Mr Madhara O, Mr Mazipo T and Miss Mudhumo S from Christian Care, Mr Zinyoro T. from World Vision, Mr Hamadziripi, Mrs Ndongwe, Mr Homela and the whole Chivi AREX staff. Chivi community members who participated in questionnaires and focus group discussions, you sacrificed your time and energy to this study, be blessed. Your participation helped a lot in the shaping of this thesis.

I further extend my appreciation to my friends and colleagues. I really appreciate your support and encouragement. Ms Tshimangadzo Ratshivhedelo, Ms Kudakwashe Chirobe, Mr Derrick Fulufhelo Chabalala, Mr Xico Simango, Mr Dennis Kalobo, Mr Tshivhase T.D, Mr Glynn Pindihama, Mr Simbarashe Kativhu, Mr Mavhuru Blessing and Mr Zongo Kom, may God richly bless you.

To my parents Tafireyi and Florence as well as my siblings Precious and Pepukai, thank you for the support. To my husband Alugumi Samuel Ndou, your support and dedication to the completion of this thesis was amazing, thank you very much.

LIST OF OUTPUTS

1. Chineka, J., Musyoki, A., Kori, E. & Chikoore, H., 2019, 'Gender mainstreaming: A lasting solution to disaster risk reduction', Jàmbá: Journal of Disaster Risk Studies 11(3), a723. https://doi.org/10.4102/jamba.v11i3.723.

2. Chineka,J., Nethengwe, N.S. & Chikoore, H. [n.p]. Adoption of Conservation Agriculture as a disaster risk reduction tool in Chivi District, Zimbabwe. Intech Open, Disaster risk resilience: Book Chapter (Under review).

LIST OF ACRONOMIES

ACCF: Adapt to Change Conceptual Framework

AGRITEX: Agriculture, Technical and Extension Services

ARC: Agricultural Research Council

AREX: Agriculture Research and Extension

ATLAS.ti: Archive of Technology, Life world and Language. Text interpretation

CA: Conservation Agriculture

CARE: Cooperative for Assistance and Relief Everywhere

CBA: Community Based Adaptation

CIMMYT: International Maize and Wheat Improvement Center

DFID: Department for International Development (UK)

ENSO: El Nino Southern Oscillation

ESAP: Economic Structural Adjustment Programme

EU: European Union

FAO: Food and Agriculture Organisation

FGD: Focus Group Discussion

FTLP: Fast Track Land Reform Programme

GDP: Gross Domestic Product

GWL: Global Warming Level

HIVOs: Dutch Humanistich Instituut voor Ontwikkelingssamenwer king/
Human Institute for Cooperation with Developing Countries

IBM:	International Business Machines
ICRISAT:	International Crops Research Institute for the Semi-Arid Tropics
IFAD:	International Fund for Agricultural Development
IPCC:	Intergovernmental Panel on Climate Change
ITDG:	Intermediate Technology Development Group
ITDP:	Institute for Transportation and Development Policy
LFA:	Logical Framework Analysis
LPA:	Livelihoods Platforms Approach
NAPA:	National Adaptation Programmes of Action
NAPAs:	National Adaptation Plans
NCCR:	National Climate Change Response Strategies
NGO:	Non-Governmental Organisation
PSNP:	Productive Safety Nets Programme
RBA:	Results Based Assessment
SADAP:	Southern Africa Development Analysis Project
SEL:	South Eastern Lowveld
SIA:	Social Impact Assessment
SL:	Sustainable Livelihoods
SLF:	Sustainable Livelihoods Framework
SPIR:	Strengthening PSNP 4 Institutions and Resilience
SPSS:	Statistical Package for Social Sciences

SWL: Set Warming Levels

ToC: Theory of Change

UN: United Nations

UNDP: United Nations Development Programme

UNFCCC: United Nations Framework Convention on Climate Change

UNISDR: United Nations International Strategy on Disaster Reduction

USA: United States of America

USAID: United States Agency for International Development

VLIR-UOUS: Vlaamse Interuniversitaire Raad Universitaire Ontwikkelingssamenwerking/ Flemish Inter-universities Council-University Development Cooperation

WFP: World Food Programme

ZCATF: Zimbabwe Conservation Agriculture Task Force

ZimSat: Zimbabwe National Statistics

ZIMVAC: Zimbabwe Vulnerability Assessment Committee

ZNCPC: Zimbabwe National Contingency Plan Committee

ABSTRACT

Conservation agriculture (CA) which is an agricultural system with the capabilities of conserving soil and water through its zero to minimal tillage, mulching and crop rotation principles has become popular the world over. This study evaluated CA as an adaptation tool to drought in Chivi district, Zimbabwe. It developed a model to enhance adaptation to drought in Chivi and other areas of similar environment. The VLIR-UOUS (2019) Theory of Change (ToC) principles structured interview checklist was used to review the Logical Framework of CA to establish the project design. Questionnaires, key informant interviews and Focus Group Discussions were used to characterise the nature of CA in Chivi and to assess the socio-economic impact of the project. Official records were used to compare food crop production yields per hectare under conventional and conservation agriculture. Atlas.ti 8‘s capabilities such as Co oc for frequency of occurrence, Co-code Doc Table for numeric analysis, Networks and report tools for visual and text analysis were employed in data analysis. Statistical Package for Social Science (SPSS version 22) was used for its uni-variate and bivariate analysis capabilities. The findings highlighted weaknesses in the Chivi CA principles and project design. It noted a low adoption of the project with some farmers withdrawing from the project against a downward trend in food production, despite CA having higher yields per hectare. The study also noted low socio-economic impact of CA as a project and its potential outside the project framework. The study concludes that CA has can alleviate the drought effects if the project’s framework is adjusted to suit local context.

Key words: adaptation, conservation agriculture, resilience, drought, vulnerability

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CHAPTER 1: PROBLEM DEFINITION AND SETTING

1.0 Introduction

Conservation agriculture is an agricultural system which seeks to improve food security and reverse soil degradation in the face of climatic risks such as drought (Pedzisa, 2016 and Mafongoya, 2016).This thesis evaluated CA as an adaptation strategy to drought in Chivi district, south of Zimbabwe. It highlighted strengths and weaknesses of the CA project in Chivi and developed a model to enhance adaptation to drought in Chivi and other communities of similar environments. This chapter gives research background, the problem statement and its setting. It also delimited the study area and gave an outline of the chapters.

1.1 Background

Drought which is a prolonged abnormally dry weather condition, characterised by a deficit in mean annual rainfall has become a distress the world over (FAO, 2013). Regionally, one third of African population live in drought zones while 220 million are exposed to drought each year (FAO, 2003). This can be attributed to the poor socio-economic status, political instabilities and lack of capacities on institutions managing disaster risks. Drought is characterised by environmental, social and economic impacts, with the agricultural sector bearing the brunt most, especially in the developing countries (FAO, 2013). United Nations Framework Convention on Climate Change (UNFCCC, 2013) predicts that Africa will experience water scarcity and stress with potential conflicts over river basins by 2025. Subsequently agricultural production will severely decline. Drought frequency has been very high in Africa since the 1960s (Shiferaw *et al.* 2014:68). Zimbabwe, continues to face recurrent droughts. World Bank (2017) estimates that approximately 3, 5 million Zimbabweans are food insecure and the figures can surge if drought persists.

Drought is persistent in Chivi district, and its frequency is increasing. Masendeke (2003) and Mudzonga (2012) note a drought frequency of three in every five years to recur in two consecutive farming periods. Chineka (2016) concedes and informs that mild droughts are experienced in Chivi after every two years. This has deeply affected agriculture which is the main source of livelihoods in the area. Chivi district's water resources are depleting while agricultural yields are decreasing and subsequently food crisis is deepening (Chaguta, 2010 and Nhodo *et al.* 2010).

Among other coping strategies, Chivi District adopted CA in 2003 to avert drought shocks, (Mudavanhu and Chitsika, 2013). According to FAO (2013) CA aims to minimize soil disruption and water loss and improve productivity, an adaptation strategy desperately needed by smallholder farmers. In 2003, the Zimbabwean government through Agricultural Research and Extension (AREX) together with NGOs introduced CA as an adaptation strategy to curb the effects of drought in Chivi District and other areas in Zimbabwe. The CA project was implemented under three principles namely zero till, mulching and crop rotation (Mazvimavi, 2010). Zero till is farming without tilling the soil so as to avoid soil erosion and loss of the top soil, while mulching involves covering the soil permanently with crop residues to avoid soil moisture loss and crop rotation is continuous change of crop varieties on a piece of land to avoid loss of soil nutrients (ZCATF, 2009). CA has a potential to maximize water and nutrients use in crop farming and subsequently increase agricultural productivity.

Chivi District comprises of mainly small holder farmers who practice mixed farming thus livestock husbandry and crop farming. Chivi falls under Agro ecological region five, an area which receives average annual rainfall of less than 500mm (Mudzonga, 2012). Most of the farmers in the district are subsistence farmers, producing mainly food crop varieties such as maize, sorghum, ground nuts and millet. Chivi farmers mainly use conventional farming in crop production. An animal pulled disc plough is used to make planting furrows. This loosens the top soil and result in soil nutrients loss and soil erosion in the sandy loam soils of Chivi. Farmers have devised a culture of interlinked mixed farming, a system where the waste product of one system is an input in the other system. For instance crop residues are used to feed livestock and in turn manure from livestock add nutrients to crops. To improve yields, curb the effects of drought and ensure food security, strategies responsive to these contingencies had to be sought. Hence CA has been widely endorsed as antidote (Gukurume *et al.* 2010).

CA is a crop management system with a potential to conserve, improve and make efficient water and nutrient use (FAO, 2013). It is defined as a complex technology which consist of multiple components ideal for smallholder farming. It is viewed as viable land management tool in agriculture which is based on enhancing natural biological processes above and below the ground (Varia *et al.* 2017).The concept is based on three principles of minimal soil tillage, crop rotation and mulching (Thierfelder *et al.* 2015). Farooq and Siddique (2015) corroborates and add a fourth principle which is integrated weed control. CA in Chivi uses the three main principals of mulching, crop rotation and minimum soil tillage where planting basins and riper tines are used Zimbabwe Conservation Agriculture Task Force (ZCATF, 2009). However its effectiveness as a drought adaptation strategy in semi-arid rural communities such as Chivi remains questionable. Nevertheless adaptation strategies needs to be constantly evaluated to ensure their effectiveness and sustainability.

1.2 Statement of the problem

Frequent droughts have become a challenge in agriculture especially in the semi-arid regions of Zimbabwe (Chifurira and Chikobvu, 2010; Chaguta, 2010 and Mudzonga 2012). This among other challenges has affected agricultural productivity and food security in the country. According to FAO (2013), Zimbabwean agriculture production trend is declining. Agricultural yields average below a tonne per hectare resulting in persistent cereal shortage despite large areas under cultivation. In recent years, extreme temperatures and cycles of heat waves also characterise the Zimbabwean weather patterns. Most of the small holder farms lie in the dry, semi-arid regions of Zimbabwe such as Chivi district. This has affected profitability of agriculture, sustainability of smallholder farming, general livelihoods of people and increased vulnerability of communities to the scourge of climatic shocks such as drought.

Chivi soils have low water retention capacity due to their porous nature and are easily susceptible to both wind and soil erosion (Chifurira and Chikobvu, 2010 ; Mafumbabete, 2019 Manzungu and Mtali, 2012). Hence continuous dry seasons heavily impact on agriculture yields. Considering this context there is a need for sustainable and effective drought adaptation strategies in Chivi.

CA which is a climate smart agriculture system which conserve soil and water through its minimal tillage, mulching and crop rotation principles is increasingly getting acceptance as an antidote in agriculture systems globally (Nhodo *et al.* 2010 and Thierfelder *et al.* 2012). The technology has been successfully adopted in countries such as Zambia where annual maize crop financial gross margins increased by 240 to 400% per hectare, Laipikia district of Kenya where crop yields doubled and in Tanzania where agricultural income rose from 34 500 in conventional agriculture to 213 050 Tanzanian Shillings under CA (FAO, 2011; Kaumbutho and Kienzle, 2007 and Shetto and Owenya 2007). Despite CA having been successful in some southern Africa countries with similar climatic characteristics to Zimbabwe, its adoption in Zimbabwe has been noted to be very low and in worst case scenarios, participants are withdrawing from the project (Marongwe *et al.* 2012 and Pedzisa, 2016). Considering the benefits of CA in other areas, there is a need to evaluate the CA project and pick its loose ends and maximize its adoption so as to enhance its effectiveness as an adaptation strategy to drought.

The government of Zimbabwe is supporting and promoting CA to address agriculture challenges including drought. However the suitability of CA among smallholder farmers has been questioned (Gukurume, 2013 and Nhodo et al.2010). Michler (2019) assessing CA in different environments across the world alludes to the adverse effects of one size fit all in CA systems. Hence there is also a need to examine the effectiveness of CA as drought risk reduction tool among semi-arid small holder farmers.

1.3 Research aim and specific objectives

1.3.1 Research Aim

To evaluate the effectiveness of CA as an adaptation strategy to drought in Chivi district, Zimbabwe.

1.3.2. Research Objectives

1. Characterise the nature of CA project in Chivi.
2. Evaluate the adoption of CA in the district.
3. Compare and evaluate food crop yields per hectare under CA and conventional agriculture in the district.
4. Assess the socio-economic impacts associated with CA in Chivi.
5. Develop a conceptual framework to enhance CA's effectiveness as a drought adaptation strategy in Chivi district and other areas of similar environment.

1.3.3 Research questions

1. What is the nature of CA project in Chivi?
2. How has the CA been adopted by the community?
3. How much food crop is being produced per hectare under conventional and conservation agriculture?
4. What are the production costs under CA in Chivi?
5. What socio-economic impacts has CA made in Chivi?

1.4 Delimitation of the study area

1.4.1 Delimitation of the study

This study focused on evaluating the effectiveness of CA as an adaptation strategy to drought. The study characterised the nature of CA in Chivi, evaluated CA adoption, compared and evaluated food crop production per hectare, assessed socio-economic impacts of CA and subsequently developed a framework to enhance CA as an adaptation strategy to drought in Chivi and other areas of similar environment. The study took a Monitoring and Evaluation approach on existing CA projects to evaluate the effectiveness of CA as a drought adaptation tool. It focused on CA project and all its stakeholders. Data was elicited from these stakeholders. The scope of the study was limited to CA only and did not consider other projects in Chivi.

1.4.2 Description of study area

1.4.2.1 Chivi District

Zimbabwe is a landlocked country found in the southern part of the African continent. It stretches within the tropics between grid reference 16^0 00' 55, 6'' S and 22^0 09' 17, 5'' E (Mafumbabete, 2019). The country has a mean elevation of 961m and covers 390 757km^2. Zimbabwe share borders with Zambia in the north, Mozambique to the east, Botswana to the west and South Africa to its south. It has a population of 15, 6 million and a population density of 37, 60/km^2 (WFP, 2017). Zimbabwe has a land area of 386.847 km^2 and 3,910 km^2 covered by water (FAO, 2018). The country's agriculture sector contributes 12% to its GDP, however about 5, 3 million people are food insecure, with 63% living under the poverty datum line (WFP, 2019 and ZIMVAC, 2017). Zimbabwe is a drought fragile country due to El Nino related recurrent droughts and over 1,6 million people receive drought relief since 2015 (USAID,2019). Zimbabwe consists of ten provinces, namely Bulawayo, Harare, Midlands, Mashonaland Central, Mashonaland East, Mashonaland West, Matebeleland North, Matebeleland South, Manicaland and Masvingo (ZimSat, 2012). Chivi District is located on the south western part of Masvingo Province.

Chivi District consists of Chivi North, South and Central constituencies. Chivi lays on grid reference 20^0 30' 0" South and 30^0 34' 60''E the District is found in the South-western part of Masvingo Province in Zimbabwe. The District has a population of 166 049 in 32 wards with 45.6% males and 54.4% females (ZimVAC, 2017) where focus was on all wards in which the project was implemented. Chivi has an average household size of 4.4 people (ZimVAC, 2017). The area is basically rural characterised by communal lands where subsistence mixed farming is practiced (Madzvamuse, 2010).

1.4.2.2 Topography

Chivi is found in the semi-arid lowveld agro-ecological region five of Masvingo province. Semi extensive farming is practiced and it is characterized by low growing periods and low agricultural productivity (Mudavanhu and Chitsika 2013: 29). According to Chiripanhura (2010:11) one third of the district is in region four, an area receiving between 500 to 650mm and the rest is in region five which receives less than 500 mm of rainfall annually.

Chivi is characterized by sandy soils. Makuvaro (2014) point out that soils range from sands to vertisols but they are mostly coarse grained sands, very infertile and prone to forms of erosion. The district has low agricultural potential and crop growing period (UNDP, 2012). Thorny and Colophosepermun (Mopane) trees characterize the vegetation scene in Chivi (Chikodzi and Mutowo, 2013).

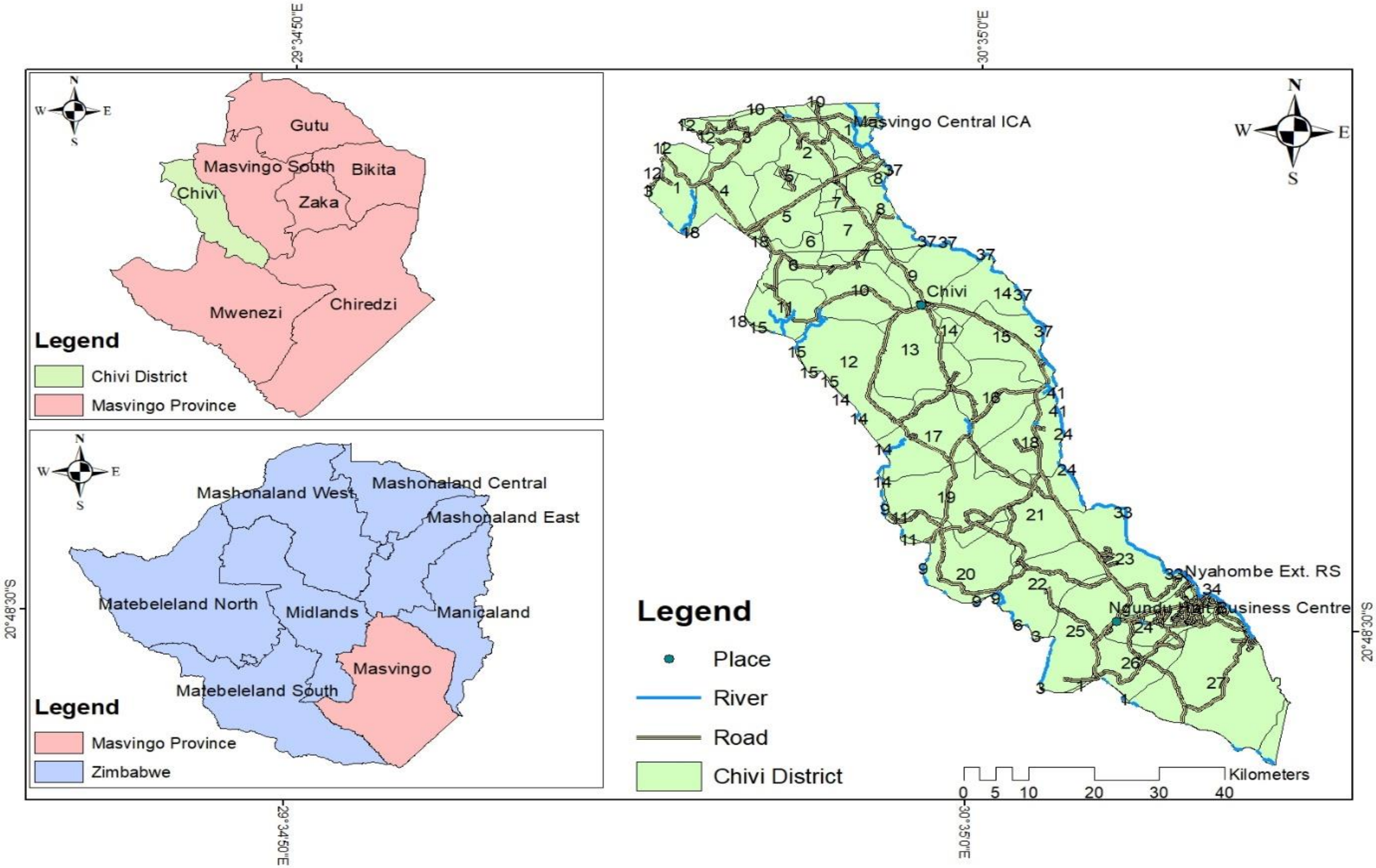

Figure 1.1: Map of Chivi district (Source: Author, 2020)

1.4.2.3 Mean climate of Chivi district

The district forms part of the south east Lowveld region of Zimbabwe (SEL), an area which receives low, unreliable rainfall with a mean annual of 530 mm. This threatens food security (Mapanda and Mavengahama, 2011:2919). Maximum daily temperatures average 28℃ and often results in high evapotranspiration rates and useful soil moisture content reduction (Mudavanhu and Chitsika, 2013:29). The area is characterized by low erratic rainfall which is ostensibly variable in time and space, with a variation coefficient of greater than 35% (Mudzonga, 2012 and UNDP, 2012:7).

Chivi is often marked by below average rainfall and frequent drought (Chikova *et al.* 2013). Chiripanhura (2010) informs that crops fail in this district, frequently due to drought. Mudzonga (2012) concedes with this view and informs that though droughts are frequent in this district they are magnified by deep poverty which affects 70% of the rural people in Zimbabwe. According to Unganai and Mason (2002), inter-annual rainfall variability is mainly influenced by the El Niño Southern Oscillations (ENSO). A marked trend towards reduced rainfall inter-seasonally, has been noted in this area.

1.5 Significance of the study

Agriculture productivity in southern Africa is declining (FAO, 2011). Marongwe et al. (2012) note that agricultural yields in Zimbabwe are averaging less a tonne per hectare, resulting in protracted food insecurities despite farmers having large pieces of land. In Zimbabwe rainfall patterns have become erratic and droughts more frequent (Unganai et al. 2002, Chineka, 2016). Hence communities are in dire need of effective, long-term strategies to cope. With global climate change projections predicting, drier semi-arid regions, the future food security is not only hinged on productivity and availability of food reserves but on addressing the challenges posed by climatic risks such as drought. Resilience of agricultural technologies is critical in communities where agriculture is the backbone such as in rural Zimbabwe. CA is one humanitarian initiative introduced in Chivi district, to curb drought effects and ensure food security. Hence this study seeks to ensure that the project yields the desired benefits.

The same CA project in Chivi was implemented in Zambia and increased annual maize crop gross margins per hectare by 240 to 400%, FAO (2011). In Laipikia district of Kenya crop yields doubled and in Tanzania annual agricultural gross income rose from 34 500 Tanzanian Shillings per hectare in conventional agriculture to 213 050 Tanzanian Shillings under CA (Kaumbutho and Kienzel, 2007and Shetto and Owenya, 2007). CA project in Chivi has been characterized by conflict and contestations and its adoption has been very slow. It is within this breadth that this study seeks to examine the weaker lines within this project.

Despite all the echoes of CA success in literature (FAO, 2011; Kaumbutho and Kienzel, 2007and Shetto and Owenya, 2007) there are also different views on the subject. CA feasibility has been queried in smallholder farming systems (Nhodo et al. 2010 and Pedzisa, 2016). Michler (2019) also questioned its applicability in different climatic regions. This research does not only seek address to these queries but also to appraise CA under persistent drought conditions.

Most research on drought in Zimbabwe highlight on vulnerability and coping mechanisms and recommending several adaptation strategies (Chaguta, 2010, Mudzonga, 2012, Mudavanhu and Chitsika, 2013). This study seeks zoom into the recommended coping mechanisms and evaluate their effectiveness as adaptation strategies. Literature on CA in Zimbabwe is more centered on the adoption of the project and its productivity (Mazvimavi et al. 2010; Marongwe *et al.* 2011; Mafongoya, 2016, Mugandani and Mafongoya, 2019). This research seeks to close that gap in literature by evaluating effectiveness of CA as an adaptation strategy.

This research unveils a framework which clears parameters for adoption of CA and enhance its effectiveness as an adaptation strategy to drought in Chivi and other areas of similar context. The model is not only generic but flexible and multi-disciplinary it can be used for adaptation to any rural developmental project under various sectors. The study offers baseline data and guideline framework to policy makers, climate risk, climate change and developmental projects practitioners.

1.6 Operational Definitions

Adaptation

Adaptation in vulnerability studies refers to long term coping. IPCC (2013) defines it as a natural or human system adjustment to a climatic stimuli, it is a process of adjusting to a current or expected climatic event. This definition brings two phases of adaptation thus adjusting to a prevailing climatic condition, an autonomous adaptation and adjusting in anticipation of a climatic risk, which is a more planned anticipatory initiative. Adaptation also constitutes purposeful and autonomous adaptation, in which purposeful is policy guided and involves control from external parties while autonomous is natural and entails internal response of the community (Jooste *et al.* 2018). This definition is in line with (IPCC,2014), which notes that adaptation can occur in a variety of ways, ranging from policies, capacity building , planning, social, physical and behavior change across temporal and spatial scales. The social aspect is also further accentuated by Tabara *et al.* (2019) who note that adaptation is a social transformation, controlled by policies characterised by endogenous development which emanates from social learning.

Conservation agriculture

CA is a farming system that helps to achieve goals of sustainable and profitable agriculture (Ntshangase *et al.* 2018 and Mugandani and Mafongoya, 2019). This definition is derived from the system's ability to conserve natural resources such as water and soil crucial in agriculture(Akter and Ghatala, 2014). CA formerly known as Conservation tillage is a cost effective, environmentally friendly method of farming that promotes minimal tillage, permanent soil cover, crop rotation so as to ensure better soil health and productivity (FAO, 2019). Michler (2019) defines it as a sustainable, climate smart agricultural production that employ low tillage, permanent ground cover and crop rotation. It is viewed as a climate smart technique due to its ability to reduce greenhouse gas emissions, energy and water use efficiency (Mafongoya *et al.* 2016). In the Zimbabwean context, CA is viewed as a strategy to improve food security and reverse soil degradation in the face of climatic risks, with a potential to address many agricultural challenges, through its three principles of minimal soil tillage, crop residue retention and rotation

(Marongwe *et al.* 2011; Pedzisa, 2016; Mafongoya, 2016, Mugandani and Mafongoya, 2019).

Drought

Drought is a prolonged period of below average rainfall. Amadeo (2019) defines it as a reduction in precipitation for a prolonged period. However the concept of drought varies from place to place. The Naumann et al. (2015) note that in Atlanta, Georgia where average rainfall is 127 cm, so drought occurs any period which receive precipitation below this average, while in South west America such as in Phoenix and Arizona, drought is pronounced after receiving an amount less than 25 cm. University of Nebraska concurs to this definition and also adds that the concept differs with spatial location and function. For instance from a meteorology point of view, drought is a dry atmospheric condition characterised by below average precipitation, while in agriculture its defined as a protracted period of deficiency in soil moisture causing crop loss and in hydrology it is referred to as a shortage in water supply resulting in low ground recharge. FAO (2013) adds on to the list the socio-economic drought refers to the compound effects of all droughts on livelihoods and the economy.

Resilience

Resilience is defined as a yardstick to the amount of perturbation a system can withhold and still maintain its functions and structure (Cosens, 2013). In disaster risk studies, resilience is described as the community or system's ability to resist, contain and recover from the hazard risks it's exposed to efficiently and timeously by preserving and restoring its structures and operations (UNISDR, 2008). The IPCC (2013) adds on this definition, giving a more ecological perspective. It defines it as the system's ability to absorb disturbances retaining its normal structure and function. Resilience can be perceived in three contexts, resilience as a response to some perturbation, the system' capacity to re-organise itself and the capacity to learn and adapt (McEvoy *et al.* 2013). Resilience is viewed as an intrinsic or emergent feature of a social-ecological system. However this manifests through exposure to the shock (Tyler and Moench, 2012). Berkes and Ross (2012) support this view and inform that though communities build resilience through exposure to shocks, they do not have all the control over shocks but they possess an ability to change many of the conditions that affect them. This ability is built over time through social learning, social networks, innovative economy, infrastructure, good governance and readiness to change.

Vulnerability

The word vulnerability emanates from a Latin word "vulnerare", meaning a wound (Luna, 2018). IPCC (2013) describe vulnerability as a measure of the present state of a community or system's exposure to hazards. Vulnerability varies widely across the communities, sectors and regions and so is its definition. In disaster risk studies, vulnerability focus on underdevelopment and exposure to climate variability and other threats, in which it is manifested by human conditions such as poverty and malnutrition (Downing *et al.* 2005). The third report of IPCC clearly illustrates this by defining vulnerability as the residual impact of climatic risks after adaptation strategies are put in place. Thus Vulnerability= Risk-Adaptation. Fellman (2012) defines vulnerability as a function of character, magnitude, rate of climate change and variation to which the system is exposed, its sensitivity and adaptive capacity. In this vulnerability is defined in the context of socio-economic factors. Vulnerability is not a permanent condition and neither is its magnitude static, it changes with time.

1.7 Layout of the Thesis

The thesis is structured in a book format, whereby chapter 1 gives the introduction of the study, Chapter 2 reviews relevant literature, Chapter 3 presents the methodology followed and Chapters 4 to 9 presents and discuss the findings on each and every objective of this study.

- Chapter 1 gives the general introduction and research background of the study, research aim, objectives, research hypotheses, delimitation the study, significance and justification of the study, working definitions and chapter outline. It also introduces the whole thesis.
- Chapter 2 reviews literature on drought vulnerability from a global perspective to Chivi district context, gives an overview of the adaptation concept and related challenges, the concept of CA, its adoption and constraints and theoretical

frameworks in evaluating resilience as well as the Conceptual framework of the study.

- Chapter 3 discusses the research design used, sampling, data collection methods, data analysis and presentation.
- Chapter 4 presents research findings and discusses the nature of CA project in Chivi.
- Chapter 5 discusses the adoption of CA project in Chivi. The general technology adoption figures, increases in acreage of land under CA and social acceptance of the project.
- Chapter 6 compares food crop yield per hectare under CA and Conventional agriculture.
- Chapter 7 discusses the socio-economic impacts associated with Conservation Agriculture in Chivi.
- Chapter 8 develops a conceptual framework model to enhance CA adoption in Chivi and similar environments.
- Chapter 9 provides a synthesis of the research work, highlighted research gaps identified, provides recommendations.

1.8 Summary

Drought has become an issue the world over. In semi-arid regions such as Chivi, food security is under threat (FAO, 2011). Agricultural yields in Chivi district are decreasing partly due to recurrent drought, (Chineka, 2016). Despite the government of Zimbabwe backing CA as an adaptation strategy in the District, the project has been shunned and its adoption remain low (Mazvimavi, 2010 and Gukurume *et al.* 2010). CA has however yielded good results in similar environments in southern Africa, (FAO, 2011). There is therefore a need to assess the CA project in Chivi to build a more drought resilient community. This thesis focuses on evaluating CA as a drought adaptation strategy in Chivi. The first chapter gave the background to the study, placed the problem statement in context, outlined the research aim, objectives and premises as well as spelt the outline of the thesis.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Climate risks such as drought have brought on a plethora of challenges globally, especially on the agriculture sector. In Africa, where agricultural systems rely on rain, droughts have threatened agriculture yields resulting in food insecurity and humanitarian crisis (Winkler *et al.* 2017). This has in turn opened up a multiplicity of research issues such as the nature and extent of droughts globally, vulnerability, mitigation and adaptation. Total mitigation becoming more challenging, focus in research has shifted to adaptation. Recent research is now examining feasibility, effectiveness and sustainability of various adaptation strategies. In Zimbabwe, there has been a lot of research on climatic risks, such as drought (Brown *et al*. 2012; Chagutah, 2010; Madzvamuse, 2010; Mudzonga, 2012). Climate risks such as drought in Zimbabwe are normally short term fluctuations from the mean climate due atmospheric El Nino Oscillations and cold currents such as the Botswana current impeding cloud burns (Unganai, 2002 and Dube, 2008). Even though literature does not directly link droughts in Zimbabwe to climate change, the later has also been listed as a potential cause for variability in climatic patterns (Chaguta, 2010 and Mudzonga, 2012). This chapter reviews literature on drought vulnerability from a global scale to Zimbabwean context, drought adaptation strategies in Zimbabwe, CA and food crop production trends in Zimbabwe, concept of CA, CA potential, CA adoption and factors influencing its adoption, CA adoption constraints in Zimbabwe, developments in evaluating adaptation strategies, knowledge gap and conceptual framework.

2.1 Drought vulnerability at a global, regional and national level

Drought has become a distress the world over (FAO, 2003). Southern Africa is characterised by frequent severe droughts. According to Chaguta (2010) droughts have become a major climatic disaster throughout the region. In Zimbabwe, drought accounts for 6 out of 10 top disasters between 1982 and 2011 Zimbabwe National Contingency Plan Committee (ZNCPC, 2013:8). Extreme weather events have been a persistent phenomenon over Africa. However, recent research informs that they have become more frequent (Mudzonga, 2012 and Chineka, 2016). Kandji *et al.* (2006:8) noted that droughts are diverting from the normal 10 to 20 year frequency. Mudavanhu and Chitsika (2013: 29), in support to this, noted a steep rise in drought frequency in semi-arid parts of Zimbabwe of a 3 year interval.

In Zimbabwe, vulnerability is more pronounced in rural areas, especially in the semi-arid agro-ecological regions 4 and 5. These regions receive very low average annual rainfall of between 400 to 600mm (Unganai, 2009). Chagutah (2010) noted a low mean annual range of between 200 to 500 mm for some of these regions. These areas are also characterised by increasing aridity. Mugandani (2009) noted that aridity is intensifying in all agro-ecological regions of Zimbabwe, with region 4 and 5 getting more drier. Besides receiving low rainfall annually, these regions are also characterised by poor loam sandy soils with low water retention capacity.

Most of the susceptible communities are within dry geographical locations, where rainfall exhibits considerable spatial variability (Brown *et al.*, 2012). However a number of studies on Zimbabwe, for example (Chagutah, 2010 and Mudzonga, 2012), relate vulnerability to overdependence on rain-fed agro-pastoral farming. Brown *et al.* (2012) concede, basing their view on economic growth levels which showed a high Gross Domestic Product (GDP) of 5.5 % between 1980 and 1990, and then a drastic fall between 2000 and 2008. They relate vulnerability to the challenges associated with the land reform programme. This view, however, does not account for marginal areas such as Chivi and most communal areas, where land was not repossessed on a large scale.

Like many other developing countries, Zimbabwean communities are vulnerable to drought. Research in Gwanda, Lower Gwelo and Masvingo revealed reduced agricultural yields, loss of livestock and poverty as some of the effects of drought in Zimbabwe (Mapfungautsi and Munhande, 2013; Chagutah 2010; Nhodo *et al*., 2010). One school of thought informs that drought vulnerability in Zimbabwean communities is disproportionate to gender. Drought is seen as a significant threat to women. Climate risks exacerbate gender dimensions of vulnerability, which arise from inequalities and gender divisions (Dodman, 2010). This view is supported by Madzvamuse (2010) who adds that 70% of women depending on small holder farming are particularly vulnerable to the knock–on effects of climate change. In the light of these views, it is imperative that focused solutions to address the root causes of vulnerability be sought.

2.2 Adaptation concept and climate risks

Adaptation is defined as the adjustments by the human and natural system in response to actual or expected climatic stimuli or other effects which moderate harm so as to take advantage of opportunities (IPCC, 2013). It refers to the capacity to adopt a coping strategy so as to minimise the effects of climate change (Mabe *et al.* 2012). According to the IPCC (2013), African countries are more prone to the effects of climate change due to low adaptive capacities. Vulnerability and coping to climatic risks are more a matter of equity and the impacts disproportionately affect those least able to bear them (Habtezion, 2012). IPCC (2007) informs that poor, marginalised communities, especially those occupying high risk areas, have low adaptive capacities and tend to rely on sensitive resources.

Globally, women are considered to be less adaptive to the adverse effects of climate change (IPCC, 2007 and UN Women Watch, 2004). United Nations Development Programme, UNDP (2010) revealed that traditional cultural norms often affect women's ability to adapt to climate change. For instance, women in Niger, are not allowed to move outside their villages. Mubaya *et al.* (2010) reveals that men cope better than women as they have a better chance to take up a variety of jobs and purchase more livestock. However, Habtezion (2012) argues that, despite women being considered more exposed to climatic risks, they are more prepared for behavioural change and most likely to support climate change adaptive policies. This is corroborated by (UNDP, 2010) which noted that despite gendered vulnerabilities, women are not simply victims to climate change. Their wisdom in resources management furnishes them with exclusive skills that are prized for the design of community based adaptive solutions. Heifer International (2010) noted increased adaptation to drought and floods by empowering women in Mumbwa, Zambia, while UN Women (2004) pointed out to the resilience and resources knowledge of women in Gaza Province, Mozambique when they were empowered to make decisions. FAO (2011) observed that coping initiatives that are not gender sensitive face the risk of inadvertently duplicating gender disparity. Hence, there is need for gender sensitive adaptation practices.

While climatic risks, such as drought, continue to threaten livelihoods and undermine community resilience, households have contrived coping mechanisms to survive with these adversities (Mudavanhu and Chitsika, 2013). Coping strategies used by communities in Zimbabwe range from food aid, relief, barter trade, food for work, drought resistant crops, water harvesting, irrigation, cross border trade and livestock selling. At household level, coping strategies are based on skills and available resources and these adaptation strategies are often differentiated by wealth or class (Munhande *et al.* 2013). The poor and middle class, for example, resort to conservation farming while the rich diversify their livestock.

Adoption of an adaptation technology also depends on the crop type being cultivated. Mabe *et al.* (2012), inferring adaptation to climate change among rice farmers in northern Ghana noted that a farmers' adoption of technology is dependent on crop preferences. They also found out that farmers are highly adaptive to the use of chemical and organic fertilizers, moderate on drought tolerant rice varieties use, mixed cropping, construction of fire belts and low on crop rotation and tree integration strategies. Human socio-economic factors also do affect choices in adoption of these strategies. Mudzonga (2012), investigating influential factors to farmers' choices of coping methods in Ward 23, Chivi District, noted that household characteristics, institutional factors such as experience, level of education, household size, access to climate change information and access to credit facilities determine adaptation methods.

2.3 Climate change and adaptation

A discourse on Climate change in literature has been multidimensional, covering social, economic, political and legal dimensions. Despite that three percent of scientists do not believe Climate change is real, it has presented insurmountable challenges globally (Gukurume, 2013). Vulnerability to climate change in Africa is due to poverty, limited coping capacity and highly variable climate (Brown et al. 2012). Chaguta (2010) concedes and noted heavy dependence on rain-fed agriculture as the cause for its vulnerability.

Due to wide spread vulnerability, limitations to climate risks and climate change adaptation discourse emerged. Adaptation is limited by the related barriers, which are a set of absolute thresholds in natural, social, economic and technological parameters (Adger *et al.* 2009). These barriers could be generic and some model based (Chameleon Research Group, 2012). The group sub-categorised these challenges into missing operator, in which there is no adaptation due to total ignorance. Missing means, which implies budgets constraints or institutional capacity and unemployed means, refer to misaligned economic incentives and complex actor relations. This is where the institutional system is too complex for effective decision-making. Research in rural communities, noted that issues of values and ethics, as well as culture, construct a society and hence influence adaptation (Adger *et al.* 2009). However, such barriers can be averted.

Institutional capacities affect adaptation in most developing countries. Most African countries lack a coherent climate change adaptation policy framework (Chagutah, 2010). Madzvamuse (2010) in a comparative study, notes that Zimbabwe and Nigeria lack effective adaptation policies and adaptation tends to be addressed by a surfeit of disjointed environmental and developmental policies. Where the National Adaptation Plans (NAPAs) and National Climate Change Response Strategies (NCCR) are, they are narrowly engaged on biophysical vulnerabilities, follow sectorial and project approaches to adaptation, hence fail to assimilate responses, as well as account for micro-level adaptation requirements. In most of these cases, women, the poor and rural societies bear the brunt. He emphasised the need to actively involve different players and responses at different levels for effective adaptation strategies. Adequate knowledge, access to information, stakeholders' involvement in decision making and gender mainstreaming are crucial in shaping pertinent and responsive interventions, (Madzvamuse, 2010). Studies in Zimbabwe, Botswana, Kenya, South Africa, Uganda and Tanzania revealed that gender is not mainstreamed into adaptation responses. Property rights tend to marginalise women and women constitute a higher percentage of lower literacy levels (Chaguta, 2010 and FAO, 2013). Thus, there is need to familiarise with gender barriers to climate change adaptation for countries to develop gender sensitive responses.

2.4 Adaptation to drought in Zimbabwe

The continuous scourge of drought in Africa makes coordinated actions, careful planning and a holistic approach critical for effective disaster risk reduction. There is a view that disasters with a slow onset, like drought, are manageable as people can prepare for them and are able to address the root causes. Turnbull *et al.* (2013:2) states that:

"*It is now widely accepted that disasters are not unavoidable interruptions to development, to be dealt with solely through rapid delivery emergency relief, but are a result of unmanaged risks within the development process itself. They occur when a hazard occurs where people are exposed and vulnerable…Conversely, disaster risk can be significantly reduced through strategies that seek to decrease vulnerability".*

This precipitates the need for proper adaptation measures to climatic disasters. The drought scourge is manageable if holistic and effective strategies are drawn. African communities have seen a large number of strategies being explored to cope with drought. These range from the top-down governmental interventions, externally idealised participatory NGOs initiatives to the most recent Community Based Adaptation (CBA) (Mudzonga, 2012; Nhodo *et al*., 2010; Musyoki *et al*., 2012). If the conflict over the top down approaches in Chivi noted by Nhodo *et al.* (2010) and the shunning of externally conceived conservation approaches by Shangani people in Chiredzi, in Zimbabwe is anything to go by, the community-based approach is the most popular approach. Musyoki *et al.* (2012) support this view basing on the success of the bottom up approach in the drought case of the Sakai region of Kenya.

However, this approach has been criticised by some scholars pointing to the limitations of the community-based approach (Reid, 2016; Ford *et al.* 2016). They argue that these projects are located at a very low level to contribute significantly on substantive issues and even understand the role of governments, thus often lack proper distribution of resources. Ford *et al.* (2016) note that, though community-based adaptation strategies empower communities, they do not address structural inequalities. Therefore, a more stakeholder inclusive approach remains critical in adaptation strategies especially in Zimbabwe where food security is continuously under threat.

2.5 The nature of Conservation Agriculture

CA is a crop management system with a potential to conserve, improve and make efficient water and nutrient use (Pedzisa, 2016). It is defined as a set of technology which consists of multiple components ideal for smallholder farming (Mazvimavi, 2010). CA is viewed as viable land management tool in agriculture which is based on enhancing natural biological processes above and below the ground (Varia *et al.* 2017). CA is a farming system that helps to achieve goals of sustainable and profitable agriculture (Ntshangase *et al.* 2018 and Mugandani and Mafongoya, 2019). This definition is derived from the system's ability to conserve natural resources such as water and soil crucial in agriculture(Akter and Ghatala, 2014).

CA is based on three principles of no to minimal soil tillage, crop rotation and mulching (FAO,2013). Farooq and Siddique (2015) corroborate and add a fourth principle which is integrated weed control. Through these principles, CA conserve soil moisture, reduce soil erosion, enhance soil fertility and reduce greenhouse gas emissions (Giller, 2009 and Thierfelder *et al.* 2017).Varia *et al.* (2017) concede and note that it is a holistic approach to achieve sustainable and profitable agriculture. CA is also viewed as a climate change mitigation and adaptation tool. According to Thierfelder *et al.* (2017) CA is a climate resilient cropping system used to adapt to the increasing threats of climate variability and change. Varia *et al.* (2017) in support add that CA reduces greenhouse gas emissions at a farm level, which makes it a climate smart and sustainable agricultural system.

CA was derived from conservation tillage, an initiative designed to respond to denudation and depletion of agricultural production resources (Varia *et al.* 2017). According to Farooq and Siddique (2015) tillage dates back millions of years ago due to a paradigm shift in human evolution from hunting and gathering to sedentary and conventional agriculture along Tigris, Euphrates, Nile, Indus and Yangste valley. However the idea of tilling the soil begun around 3000 BC in Mesopotamia. It is after the 19^{th} century Industrial revolution that machinery was introduced in agriculture with the aim of softening the soil for maximum productivity (Farooq and Siddique, 2015).

The effects of tillage agriculture started to be felt, research questioned its use in vulnerable ecosystems around 1930 when dust bowls devasted parts of western USA

(Friedrich *et al.* 2012). There is a consensus that the first references to no till farming was around 1945 (Friedrich and Kienzle, 2007; Farooq and Siddique, 2015). No till gained momentum around the globe in 1970's due to sufferings caused by drought in USA, increased fuel prices and developments such as seeding machinery (Haggblade and Tembo, 2003). According to Giller *et al.* (2015) expansion of no till in America and Australia in 1980s and 1990s was driven by a plethora of factors .The factors included introduction of effective herbicides such as atrazine between 1960 to 1970 and further innovations such as direct seeding, using the no till planter, the need to save fuel and supportive government policy incentives.

The advancements made in no till practices resulted in change of name from no-till to conservation tillage and conservation agriculture subsequently (FAO,2013).Though it took over 20 years for Conservation Agriculture to acquire significant adoption in America, it spread globally to Brazil, Argentina, Canada, Australia, Spain, Finland, Asia and Africa (Friedrich *et al.* 2012). By the year 2009, between 62 to 92 % of farmers practiced no-till in Brazil, North America and Australia (Llewellyn *et al.* 2012). In Africa the rationale for the spread of CA has been mainly based on its principles which conserve soil and water, qualities ideal for the African climate (Giller *et al.* 2015). A number of Non-Governmental organisations engaged in the spread of Conservation Agriculture to various areas. According to FAO (2011) CA is now being practiced over millions of hectares, worldwide on soils varying from sand to clay. However the adoption of CA is still limited to 0.3% of farmland globally (Giller *et al*. 2015).

CA has gained positive recognition globally owing to its popularity and success in North America and South America (Mlipha, 2015). Hence CA or at least one component of it is being implemented in large commercial farms (Bolliger *et al*. 2005) In Africa about a million hectares of land is under CA, in which 40% is South African commercial farms (Jat *et al*. 2012). However its adoption in smallholder farming systems and fragile ecosystems remains fairly limited due to agronomic, social, economic and technological constraints (Kassam *et al.* 2012). Currently the development of CA by smallholders is addressed under several programs from International organisations supported by research institutes such as the Conservation Agriculture Program of the International Maize and Wheat

Improvement Center (CIMMYT) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Ares *et al.* (2015).

2.6 Potential of Conservation Agriculture

CA evolved from zero tillage which was born out of a necessity to combat soil degradation and improve productivity (Giller *et al.* 2009). Most studies reveled CA to have more desirable benefits and increased productivity but this does not occur overnight (Ares *et al.* 2015). Govaerts *et al*. (2005) and Richards *et al.* (2014) note an increase in maize and wheat yields over a period of 10 years. CA also improves soil fertility. According Ares *et al.* (2015) significant increase in soil organic carbon occurs within seven to ten years after switching from machinery plough to CA, however varying with climates. CA also addresses greenhouse gas emissions. Adhiambo *et al.* (2013) 's study in Western Kenya and Eastern Uganda notes higher assimilation of methane (CH_4) in intercropping than in conventional farming while no differences were found among different tillage systems with regard to nitrous oxide (N_2O) in maize-mucuna crops. Zuniga et al. (2009) note lower N_2O and CO_2 in crop residue covered than in uncovered raised beds in Mexico. CA also reduce pest population. Ares et al. (2015) notes that tillage transport alien seeds to greater depths while increased light promotes germination, hence minimum to zero till reduce weed invasion and decrease soil pathogens and subsequently crop rotations promotes integrated pest management.

Climate change has become a great threat to food security. Evidence reveal continuously declining cereal yields in Sub Saharan Africa despite large pieces of land under agriculture coupled with high food demands out weighing supply. To ensure food security, Sub Saharan African agriculture needs to grow by 4% (FAO, 2013). However the future food security is not only depended on higher production and access to food but sustainable solutions to destructive agriculture practices (Marongwe *et al.* 2012). It is within this breadth that CA potential needs to be explored and tapped.

2.7 Conservation Agriculture adoption and its drivers

Despite the potential of CA and its importance in food security, its adoption varies widely, globally. According to FAO (2011) South America has an adoption rate of 46.8%, North

America 37.8%, Australia and New Zealand 11.5%, Asia 2.3%, Europe 1.1% and Africa 0.3%. Marongwe *et al.* (2012) concede and add that in Africa CA adoption is partial with countries, especially in Zambia and Zimbabwe. Farmers who adopt it rarely practice all its principles (FAO, 2011). In Zimbabwe CA technology has been slowly adopted, (Nhodo *et al.* 2010). Thierfelder *et al.* (2015) corroborate and inform that though smallholders in Africa are not so keen on adopting CA, there is evidence that farmers who have lower risks are adopting it without even incentives. Incentives often plays an integral role in CA adoption. Marongwe *et al.* (2012) note that CA adoption relies on donor project particularly its pull and push factors. Withdrawal from the CA project has also been noted in Zimbabwe (Pedzisa, 2016).

At a global level CA adoption drivers include energy saving, water use efficiency, reduction of soil erosion and draft power reduction (Baudron *et al.* 2015; Giller, 2015 and Thierfelder, 2017). CA‘s principles such as mulch, provides surface residue retention crucial in soil and moisture conservation. Kaweesa *et al.* (2018) in support add that this farming system besides benefitting the soil, improve agricultural yields. Varia *et al.* (2017) concede and classify CA drivers into short and long-term benefits. They noted that farmers are often attracted to short and immediate term benefits more than long term benefits. However CA benefits are fully realized in the long run and in cases where CA principles have been employed as a full package (Varia *et al.* 2017 and Michler, 2019). This then affects the full adoption of CA. Baudron *et al.* (2015) note that CA adoption varies with niches, particularly the good fit of the technology in an area. This fitness is dependent on local factors which are the factors influencing the adoption of the farming system.

Akter and Ghatala (2014) note that in Africa, socio-demographic factors are the major influencers. They found out that household characteristics are relevant to CA adoption decision making. These characteristics include age, gender, household size and education level. Level of education was found of greater importance, whereby the technical interpretation capacity of technology components, access to information and profitability influenced decision making on adoption or not. While family size is a proxy to labour availability and age of the household head had a major influence on adoption and even the extent of adoption. Ntshangase et al. (2018) in support inform that social networks are of greater importance at a community level. Their study in Malawi revealed that farmers rely much on peers in making decisions. Mugandani and Mafongoya (2019)'s studies in South Africa and Zimbabwe support this view and add that the decision to adopt CA or not is not mainly reliant on the farmer's individual perception but the community's view.

Studies on CA adoption in Europe revealed that socio-demographic factors do not have much influence on decisions of adopting CA (Knowles and Bradshaw, 2006; D'Emden *et al.* 2008; Prager and Posthumus, 2011 and Rochecouste *et al.* 2015). Soil degradation, environmental effects and profitability are the main concerns in the Europe (Prager and Posthumus, 2011). Mandatory agro-environmental policies forces farmers to abide by the recommended initiatives regardless of their preferences. D'Emden *et al.* (2008) and Rochecouste *et al.* (2015) concede and add that need to reduce Greenhouse gases (GHG) and climate change mitigation are major drivers of CA in Australia. While factors such as high productivity, fuel efficiency and supportive government incentives influence adoption decision making. D' Emden *et al.* (2008) in their studies in South Australia noted that soil quality also has an influence, farmers using high calcareous soils had low adoption. Decision was also influenced by information dissemination and paid consultancy services. Knowles and Bradshaw (2006)'s study on Europe, Latin America and SubSaharan Africa also noted these variations in CA adoption decision making. While household characteristics had much influence in Sub-Saharan Africa and Latin America, other external factors such as inputs costs, markets, source of information and interest rates also influenced decisions. However in Europe farm finance and management had a huge influence.

Africa has the lowest CA adoption figures with less than one percent of cultivated land under CA (Nyanga, 2012). Decision-making on whether to adopt CA or not has more or less similar drivers. Food insecurity, poverty, declining agricultural yields, poor soils and droughts are the main drivers of CA in Africa (Mlenga, 2015; Ndah *et al.* 2013; Nyanga, 2012 and Marongwe, 2012). A study on Malawi, Zimbabwe, Burkina Faso and Zambia revealed that acute poverty and economic crises have negatively affected agricultural production resulting in food insecurity (Ndah *et al.* 2013). Mlenga (2015) assessing factors influencing CA adoption in Swaziland supported the above findings and added drought, as one of the major drivers of CA especially in Southern Africa. He notes that CA adoption decision is informed by three theoretical perspectives namely innovation- diffusion, economic constraints and social learning.

According to Mlenga (2015) and Nyanga (2012) CA adoption is perceived as a linear sequence influenced by innovation diffusion perspective. On this, farmers get the knowledge of CA, is in a persuasion stage in which a farmer develops an attitude towards CA, gets to a decision stage, implementation and confirmation. The second theoretical perspective is the economic constraints perspective, where a farmer's adoption of CA depends on economic factors such a farming costs, markets and land ownership. The third perspective is the social learning theoretical perspective which has its roots on Bandura (1977)'s theory of learning. In this perspective, a farmer learn through observing other farmers, imitation and information sharing. Under social learning, societal values, beliefs and structures have a major influence on CA adoption.

Socio-economic factors influence CA adoption in Southern Africa. According to Mlenga (2015) in Swaziland the level of education of the household head and household size had much influence on CA adoption while access to draught power and extension services had less influence. Mavunganidze *et al.* (2013) and Chiputwa *et al.* (2013) in support also note formal education, labour availability and land sizes as major influencing factors in Zambia and Zimbabwe. Government and donor incentives also influence adoption of CA. Ndah *et al.* (2013) noted that in Malawi incentives attracted farmers to CA. This view is supported by (Pedzisa *et al.* 2015), who note withdrawing of farmers from CA due donor financial roll out in Zimbabwe. In Lesotho economic incentives are also of importance as well as the degree of trust in the lead farmer in the participatory learning approach (Silici *et al.* 2011). Farmers tend to adopt CA in areas where there is a farmer leader they trust in.

2.8 CA and food crop production in Zimbabwe

The importance of CA adoption cannot be over emphasized considering the multiple of challenges facing agricultural production in the face of climate variability and change. The global rise in drought and extreme temperatures has led to pronounced soil moisture deficit, affecting agricultural production and food security (FAO, 2019). With global warming set to increase under the Set Warming Levels (SWLs) 1.5^{0}C and 2^{0}C of the Paris Agreement, the quest for climate smart agriculture systems has risen (Xu *et al.* 2019). Africa is vulnerable to climate variability and change risks such as drought and drought tops the list of Africa's natural disasters in terms of its frequency and severity across the continent (Sithole *et al.* 2019). In Southern Africa, erratic rainfalls and drought characterize many semi-arid regions.

CA becomes even more critical in countries such as Zimbabwe, where the agricultural sector, is facing a plethora of challenges ranging from drought, poor land reform policies, and economic fallout to rising food demand (Marongwe *et al.* 2012 and Muzawazi *et al.* 2017). The country loses an estimated US$126 million every year, which is about a 7.3% of the country's agriculture GDP to production risks such as drought (World Bank, 2019). Drought tops the list of factors influencing agriculture development in Zimbabwe (Figure 2.1).

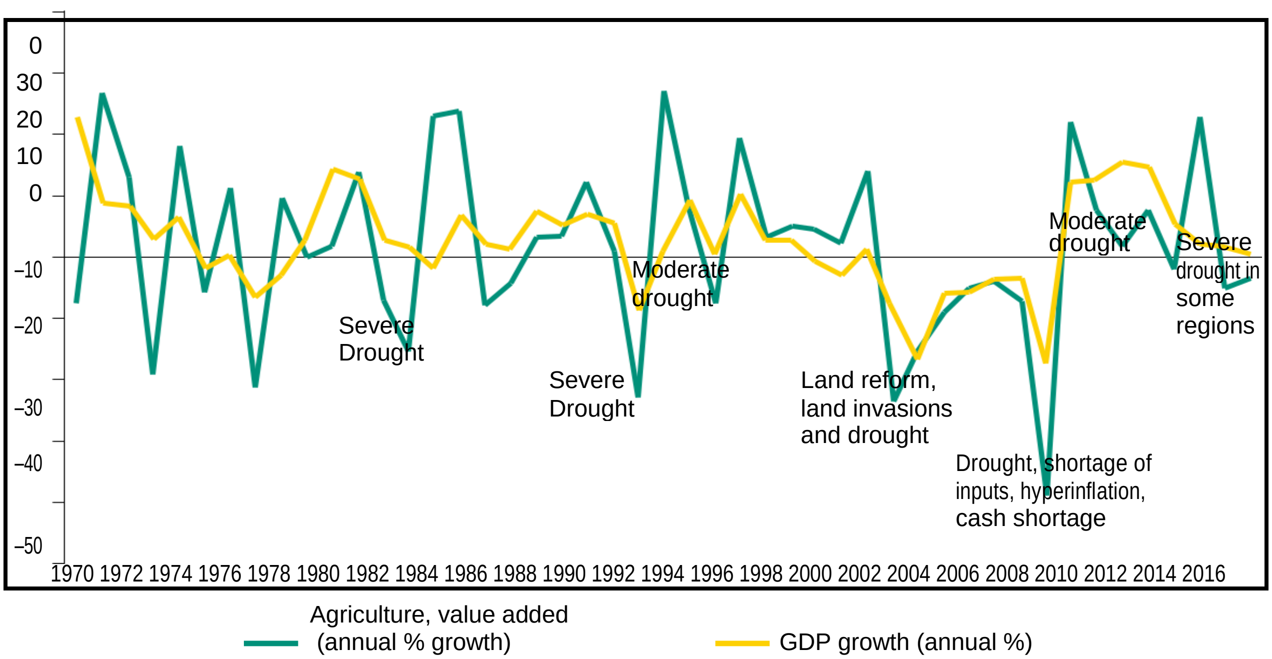

Figure 2.1: Relationship between agriculture and GDP growth under agriculture challenges in Zimbabwe (Source: Adapted from World Bank, 2019)

Drought frequency is increasing in Zimbabwe and often coupled with cycles of heat waves (FAO, 2019). The country's heavy reliance on rain-fed agriculture system has made it more vulnerable to drought (Chaguta, 2010 and Mashizha, 2018). Approximately 70% of Zimbabwean population rely on rain fed agriculture and only 37% of this receive adequate rainfall (UNDP, 2012; 2017 and Muzawazi *et al.* 2017). The country's population is rising, increasing the food demand hence the need for innovations that ensure food security.

The exponential population growth and the subsequent growth in food demands outweigh the production capacities of conventional agricultural systems especially in rain fed situations with severe environmental degradation (Pradhan et al. 2018). Zimbabwe has a population of 14.4 million and a population density of 38 people per square kilometer and projections of 17 million people by 2020 (World Bank, 2017). In Chivi District population increased from 155 640 to 166049 people in 2002 and 2012 respectively (ZimStat, 2012) An increase in population, if it's not supported by sound and clean agricultural technologies might result in the declining of agriculture production and pronounced food insecurity. Despite advancement in agricultural technologies and several initiatives, agricultural production in Zimbabwe is declining (Marongwe *et al*. 2012).

The agricultural sector of Zimbabwe has also faced a challenge of the country's land reform policies and the subsequently economic fallout. The land reform of Zimbabwe, particularly the Fast Track Land Reform Programme (FTLP) which was derived from the Land Acquisition Act of 2002, collapsed the country's agriculture sector (Marongwe. 2013). The programme sought to address the colonial injustices on land distribution, through its A1 and A2 models but its fast tracking saw massive land invasions (Mukodzongi and Lawrence, 2019). This resulted in white commercial farmers leaving the land to black peasants, with inadequate capacities to produce enough to meet the country's food demand. The aftermath of the FLTP is still being felt countrywide in terms of food shortages, lack of foreign currency and sky rocketing inflation. The small holder farmers bear the brunt most. At grass root level, poor communal farmers struggle to access inputs and increase productivity (Marongwe *et al.* 2013). It is against this background that the interest in sound and sustainable agriculture innovations such as CA is rising and its adoption critical.

2.9 Factors influencing CA adoption in Zimbabwe

Various factors influence the adoption of CA. Factors such as assets endowment and household characteristics. Mazvimavi *et al.* 2010 note that though CA targets smallholder farmers in Zimbabwe their capacities in terms of resources and social networks vary. The study noted some farmers struggled to access basal fertilisers, and that small household sizes had problems with labour in digging and weeding. CA adoption studies in Chivi noted factors such as chronic illness and conflict of systems such as using crop residue for mulch instead of feed for livestock as some barriers (Nhodo *et al.* 2010 and Mazvimavi *et al.* 2010). Socio-economic and biophysical factors have also been noted as barriers to effective CA adoption. Poor social networks build misconceptions, poor information transmission while limited financial means restrain the farmer from full CA practice (Muzangwa *et al.* 2017). Mawere *et al.* (2013)'s study on Lower Gweru District concedes these views and adds lack of credit facilities, inputs, adequate information and farmers' involvement in problem definition and decision making and demotivated extension workers as influential factors.

Interestingly these perceived barriers have been the points of CA success in some similar environments in Zimbabwe. CA's success in the dry lands of Gwanda has been attributed to the project's ability to cut on labour needs and budget principles such as use of planting basins for saving on fertilisers because of effective application (FAO, 2017). Ntshangase (2018) notes an individual's mindset as a critical factor also influencing new technological adoption. Some farmers are naturally ready to adapt to change while some are not. However if the new technology offers tangible value, such as security and convenience more people will adopt it. There is an insignificant correlation between users' adoption decision making and innate design of the new technology but rather its functions in relation to the user's social network and the environment (Giesing, 2003). Maintenance of interpersonal networks is of paramount importance in the project design to ensure its adoption. Therefore no one-size-fit all projects can be uniformly adopted in agriculture as farmers have different needs and challenges.

2.10 CA adoption and constraints in Zimbabwe

CA promotion in Zimbabwe is in its second decade, but with little success. According to Thierfelder *et al.* (2012) Zimbabwean CA dates back to the late 1990's. CA has been marketed as a sustainable technology to intensify farming through increased yields and profits while eradicating environmental degradation associated with conventional farming (Muzangwa *et al.* 2017). CA is being done through its three core principles of minimal tillage, permanent soil cover and crop rotation. The model targeting the poor and vulnerable small holder farmers uses a hand-hoe basin planting system, a very unpopular system among smallholder farmers, who consider it too laborious. CA's wide promotion in Zimbabwe has not yielded significant adoption (Mazvimavi *et al.* 2009; Nhodo et al. 2010; Thierfelder *et al.* 2012 and Muzangwa 2017). According to Nhodo *et al.* (2010) in areas such as Chivi district, the project has divided the community, with those who preferred food relief, distancing themselves from it.

CA has received a fair share of criticism in research. According to Giller *et al.* (2009) empirical evidence for increased yields, reduced labour needs, improved soil fertility and reduced erosion is inconclusive and unclear. CA has an array of principles which run concurrently hence no single method per se which can be said to contribute to effects sought in isolation. Questions such as tradeoffs of implementing CA and whether CA address farmers' needs or needs identified by scientists and policy makers still hang in balance. Nhodo *et al.* (2010) noted slow adoption of CA and questions the feasibility of the project in vulnerable rural communities such as Chivi.

Adoption of CA in developing countries has become a challenge. Ares *et al.* (2015) note a number of challenges from lack of exposure of farmers to CA technology, limited finances, shortage of suitable farming implements and extension services to unsecure land tenure. While Valbuena *et al.* (2012) documented conflicting farming practices in west and southern Africa where crop residues to be used for mulching is used for livestock feed. Lack of and or wrong information also affects CA adoption. Ares *et al.* (2015) inform that in Uganda and Lesotho farmers were being misinformed by agricultural implements sales people. Perspectives on CA social impact remains limited, Nhodo and Gukurume

(2010) note overburdening of farmers and conflict amongst community members as some of the challenges of CA in Chivi.

2.11 Effectiveness and sustainability of adaptation strategies

Sustainability is defined by IFAD Strategic Framework (2007) as ensuring that institutions are supported through projects and the benefits realised are maintained and continue after donor roll out. The organization notes that gender and human development are vital for sustainability of adaptation initiatives. Adger *et al.* (2009) highlight that sustainability is the ultimate success of adaptation actions and this occur when such actions recognize demographic, cultural economic change, technology and social systems operating. Success of adaptation strategies can be measured by a spatial scale in an area where actions are implemented (Mazvimavi *et al.* 2010). Temporal scale also measure success of resilience actions.

Adaptation to climatic risks is often evaluated through generic principles of policy appraisal. In which equity, efficiency, effectiveness and legitimacy are considered sustainable (FAO, 2003). Sustainability criteria is contested and context specific (Adger *et al.* 2009). It varies across the spatial and temporal scale.

2.12 Developments in evaluating adaptation strategies

Research has played a major role for better understanding, development of methods to support and inform adaptation in the context of disaster risk management. Past research has focused on exploring techniques to deal with perceived risks, projections, related decision making and diverse knowledge systems (Wise *et al.* 2014). Further development in adaptation research incorporated resilience principles focusing on decision making approaches and institutionalism (Haasnoot *et al*. 2013).Recent research seeks to explore adaptation pathways. According to Wise *et al.* (2014) adaptation pathways view resilience in the context of empirical evidence. Thus exploring beneficiary communities' history, assess their adaptive space and lead transformative adaptation. Different adaptation initiatives have been explored (Mudavanhu *et al.* 2010; Mazvimavi, 2010 and Chaguta 2010) to build awareness and decision making in climate change and environmental management. However many resilience actions tend to be ill-equipped to deal with multiple stress, interlinkages, and diverse institutions, (Chaguta 2010 and Wise *et al.* 2014).There is therefore need for continual evaluation of adaptation strategies and map transformative adaptive paths towards sustainability.

Past adaptation research evaluated resilience actions using the Log frame approach, thus weighing outcomes against set project objectives based on the causality theory (Nelson *et al.* 2007). In this, project inputs, activities and outputs are set as indicators for the success or failure of it. Haasnot *et al.* (2013) note the need for frameworks to shift from conceptualizing adaptation as an end process but rather a pathway of interacting global and societal change. This is conceded by Wise *et al.* (2014) who suggest a paradigm shift from past dependency, adaptation pathway to transformative cycle which recognize that global change problems are not stagnant. Béné *et al*. (2015) using the theory of change modifies the resilience measurement integrated framework. This looks at empirical evidence, factors contributing to resilience, context and relationship between shocks and responses. This framework is backed by IFAD 2007-2010 Strategic Framework which views sustainability and success of any project targeting rural communities as entrenched in gender mainstreaming and human development. The turning point of this study is that adaptation actions can lead to undesirable outcomes as well as positive results and can all change either in short or long-term. Research has revealed, multi scale and multi-level methodologies measuring adaptation actions, however many of these target recipients at household to community level when in reality ultimate effects of a shock does not only depend on their response but even that of non-direct beneficiaries (Béné *et al.* 2015). This study seeks to cover both direct and non-direct beneficiaries, collective actions and recognise the social context in which actions are implemented.

2.13 Knowledge Gap

2.13.1 Focus on agricultural productivity

Recent literature on agriculture in Zimbabwe concede that agricultural production is declining (Marongwe *et al.* 2012; Pedzisa. 2016 and Mugandani and Mafongoya, 2019). The Zimbabwean agricultural research focuses much on productivity of agricultural systems and technologies. This has seen even literature on CA focused on the project's productivity and adoption figures (Mazvimavi *et al.* 2010; Thierfelder *et al.* 2015 and

Pedzisa, 2016). However in the face of climate variability and change, the future of food security is not hinged on productivity and availability of food reserves but on addressing the challenges posed by climatic risks. With IPCC (2013) predicting further warming and moisture deficit in southern Africa, it becomes imperative to evaluate the effectiveness of adaptation strategies in the light of sustainability and holistic approaches.

2.13.2 People centered approaches

Evaluation of CA in Zimbabwe has been mainly done for process monitoring and upgrading of the technological system mainly sponsored by the projects' partners (Mazvimavi *et al.* 2010 and Thierfelder, 2015). Hence the question whether CA is addressing the needs of farmers hangs in balance. According to Chaguta (2010) the country's National Adaptation Plans (NAPAs) and National Climate Change Response Strategies (NCCRs) are narrowly engaged on biophysical vulnerabilities, follow sectorial and project approaches to adaptation, hence they fail to assimilate responses and actively involve different players at different levels. Yet the success of technology adoption has little to do with technology but the targeted people and their mindsets (Giesing, 2003). This is evident in Zimbabwe where CA adoption remains low and in some worst case scenarios farmers have abandoned the project despite the advancement of the technology from zero tillage to a more mechanized minimal tillage (Pedzisa *et al.* 2015 and Pedzisa, 2016). Hence local communities' needs have to be assessed and integrated into the adaptation strategies that benefit them.

2.13.3 Micro-evaluation of CA performance

CA literature also shows varying opinions on challenges and constraints of CA adoption. Lack of adequate information, misinformation, conflicting values especially in mixed farming systems, socio-economic factors and overburdening of farmers are some of the challenges highlighted. However some of these factors reveal contradictions in some areas (Ares *et al.* 2015; Valbuena *et al.* 2012; Pedzisa, 2016 and Michler, 2019). It is within this breadth that CA challenges and barriers for different areas become site specific and hence CA challenges for Chivi district remain a grey area.

2.13.4 Conceptualisation of adaptation strategies

Conceptualisation of adaptation as an end process characterize CA literature of Zimbabwe (Mazvimavi *et al.* 2010; Thierfelder *et al.* 2015 and Pedzisa, 2016). In this success and failure of the project is evaluated using the Results Based Approaches (RBA). Adaptation is a process, and its strategic actions can either take a resilience or vulnerability pathway (Bene *et al.* 2015). There is a need for a conceptual paradigm shift in adaptation pathways to align adaptation actions with the prevailing and ever changing global changes, thus a transformative pathway approach.

2.13.5 Multidimensional impact assessment in CA

Vulnerability to climatic risks and its impact occurs as a product of multiple stressors on the community (Turnbull *et al*. 2013).This calls for multidimensional impact assessment methodologies in evaluating the adaptation strategies. This study combines Logical Framework Approach (LFA), Results Based Approach (RBA) and Social Impact Assessment (SIA) to evaluate CA so as to critically zoom into the constraints of the project and develop a useful conceptual framework to enhance its adoption. Effectiveness or sustainability of adaptation strategies especially in agriculture encompasses resilience, profitability of the system and its sensitivity to demographic, cultural and social systems.

2.14 Theoretical and Conceptual frameworks

This study adopted the Brown et al. (2017) Livelihoods Platforms Approach (LPA) theoretical framework for qualitative analysis and evaluation of CA in Chivi. The LPA was chosen for its unique framework that integrates fundamentals of various theoretical frameworks to facilitate a better understanding of Chivi farmers decision-making and preferences. At the center of this framework is the concepts of UK (DFID, 1999) Sustainable Livelihoods approach (SL) such as the household characteristics and assets required for a sustainable adaptation to drought risks. SL emphasises the bottom up approach to developmental projects, it places people at the center of projects. In projects evaluation it looks at wider issues affecting communities' development. The analysis approach focus on both short and long-term sustainability of the particular initiative. Hence it became a useful tool in reviewing secondary information sources and linking them with primary data. The other framework integrated is the HIVOS (2015) and VLIR-UOS (2019) Theory of Change (ToC).

This ToC framework guide this study in its methodology and analysis. The concept behind the theory is that people have different and unconscious ideas about why and how the world and people should change. Also how people perceive, understand and receive change is shaped by their environment, beliefs on life, human nature and society. The framework seeks to address questions such as what change, for whom, why and who says so. ToC allowed better understanding of the CA project system so that strategies can be reviewed and adjusted.

The theoretical framework facilitates evaluation of developmental projects especially in the EU projects which uses the logical framework, hence was a useful tool in analysing the CARE International CA log frame which is an EU funded project. The framework's core principles enabled mapping grey areas or line of weaknesses within CA project. It was used to define the nature the project and the missing links.

To guide the study, Béné et al. (2015)'s climate change conceptual framework was adapted. This framework depicts CA as an adaptation strategy with potential to yield both positive and negative outcomes. It highlights that sustainability of an adaptation strategy depends on the pillars of sustainability namely, ownership, technical, institutional, environmental, political, economic and social. It is important to note that for an adaptation project to lead to a resilience pathway there are a set of standards and procedures to be followed by all stakeholders, while monitoring and evaluation is executed continuously.

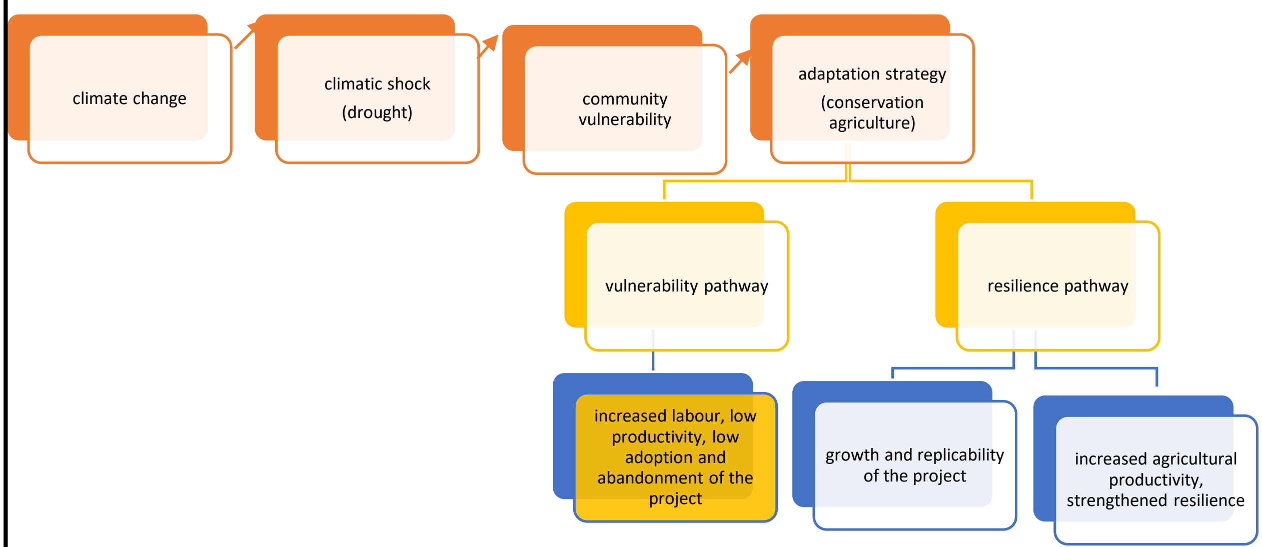

Figure 2.2: Climate change adaptation conceptual framework (Source: adapted from Béné *et al.* 2015)

The conceptual framework shows sustainability as the ability of project beneficiaries to continue reaping the benefits even after the roll out of the donor fund. The sustainability or effectiveness of an adaptation strategy lies in its design and implementation. Evaluation of adaptation projects such as conservation agriculture then becomes critical to ascertain effectiveness of the project to drought adaptation.

2.15 Summary

This chapter reviewed literature on the background of droughts in Africa, Zimbabwe and Chivi district. It also looked on drought vulnerability and adaptation at both the national and local scale. Literature on drought adaptation strategies and food crop production trends was also reviewed. CA concept, CA initiatives and perceived benefits and challenges were reviewed. The knowledge gaps in literature were also highlighted. The chapter also looked on evaluation of resilience initiatives and subsequently the conceptual framework which guide this study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

Research methodology is a strategy used to implement a research plan. It is defined as specific techniques or procedures used to identify, select, process and analyse information about a topic. It is a philosophical framework within which a research is done, it provides a foundation for research (Kumar, 2014 and Maree et al. 2016). This chapter describes the research methodology followed in this study and provides information on the plan, framework and steps which were undertaken to achieve the set objectives in a systematic manner. The chapter presents the research design, selection of participants, data collection methods, data presentation and analysis. This chapter presents methods, techniques and procedures used in data acquisition and analysis. The objectives, research questions, data collection and analysis techniques are summarised in Table 3.1. This research evaluates effectiveness of CA project in Chivi as an adaptation strategy to drought. Different techniques were used to evaluate CA as an adaptation strategy in Chivi district.

3.1 Research design

Research design refers to the strategy the researcher choose for integration of different components of the study in a more logical and coherent way. It is a plan that shifts the philosophical assumptions to give specifics on participants' selection, data collection and its analysis (Maree *et al.* 2016). This is supported and further expanded by Kumar (2014) who adds that research design is a set of methods and procedure used in collecting and analysing research problem variables. Maree *et al.* (2016) concedes that it's a framework for research planning and answering research questions. This involves making crucial decisions about what to or not to include, the criteria the researcher will use to evaluate results and make conclusions. Research design is a plan that arranges conditions for data collection and analysis to match relevance and research procedure in an efficient and systematic way, which makes it a blue print for data collection, analysis and presentation (Kumar, 2014).

This research is an evaluation study, a process evaluation study design was adopted to evaluate an adaptation strategy which has already been implemented. The rationale behind the use of this design is its capabilities to address questions such as "what was done", "to whom" and "how" (Kumar, 2014). The design was also chosen for its ability to improve interventions by providing information necessary to change strategies in the face of ever changing global conditions. This design suits well with the CA project in Chivi, which has been implemented as an adaptation strategy to recurring drought.

The research followed a mixed methods design, using Chivi district as a case study. The study employed quantitative and qualitative approaches in a triangulation way to yield an in-depth analysis of a complex human and environment interaction. Triangulation is the use of more than one design to validate and confirm the findings of the study (Carter, 2014). The mixed methods approach sought to ensure maximum data capturing which might have been compromised by using a single method (Kumar, 2014). Therefore, both methods were integrated to infer reliability of data, add value to theoretical debate and to overcome bias inherent in single method designs.

This study used various data sources. Information on the CA methods used in Chivi district was crucial, as well as the whole design of the project to ascertain its strengths and weaknesses. Official documents of AREX, CARE International and Christian Care were used. Data covering the whole project from its inception to date was examined. Key informant interviews with the department officials also yielded more information. The study needed data on the buy in or the adoption and impact of the CA project in Chivi. Food crop yields under CA technologies and conventional methods at a plot level were used. The farmers' questionnaires, focus group discussions and official documents were used to assess the adoption of the technology. Community buy in was assessed using plot extension after the initial demo plots and farmers' narratives about the project.

Agricultural profits were examined to ascertain economic impact of the project. Change in community livelihoods and related development was also used as indicators. District food crop yields under Conservation and Conventional farming were compared to determine effectiveness of Conservation Agriculture in Chivi. The average yield per hectare reflected on effectiveness of the project. Effectiveness, sustainability and replicability of the project was assessed using data on ownership of the project, capacity building and institutional strengthening. This data was obtained through farmers' questionnaires and key informant interviews targeting agricultural officials and humanitarian organisations working on this project. Social impact of the project was also assessed using positive change in livelihoods, social cohesion, gender integration and general upliftment of the society under CA.

3.2 Sampling methods, sizes and unit of analysis

According to de Vos (2011) unit of analysis refers to objects which the researcher wants to study. These include groups, individuals, organisations, programmes or social artifacts. Selection of this unit of analysis depends on the research problem and questions (Kumar, 2014). The unit of analysis for this research is Chivi District smallholder farmers, AREX and NGO officials involved in the CA project.

The research adopted a multistage cluster sampling method, for the household questionnaire. Chivi district formed the sampling population. Purposive sampling was used to select the Chivi district from other districts. This area was selected for its pronounced vulnerability to drought (Chineka 2016; Mudzonga 2012 and Chagutah 2010). The area also has a number of drought adaptation strategies including the CA.

The district has 28096 households in 28 communal wards where CA is practiced, ZimSat (2012). To calculate the sample size, Yamane (1973) formula was used, which is

Sample size n= $\frac{N}{1+N(e)2}$

Where N is the total population and e is the precision. Therefore using the precision of 5%, the sample size would be n= $\frac{28096}{1+28096(0.05)2}$

140 households

The sample size for the households was then proportionally apportioned between the 16 wards purposively sampled. To infer gender dimensions a systematic stratified sampling method was used at village level. 140 Chivi household heads were sampled.

For focus group discussions, the study used purposive sampling to select participating community members. The six wards, four with the largest number of villages and two with the least participated in this research. This ensured that more people from the community participated thus increasing objectivity in the subject matter discussions. Both gender variables, community leaders and youth were involved in these discussions to get balanced data. Key informants were AREX officials, CARE International and Christian Care officials.

3.3 Research Methodology

3.3.1. Methods of data collection

The purpose of data collection is to acquire adequate information for record-keeping, decision-making and to develop an information pool (Leedy and Ormrod, 2010). This research adopted Waddick's (2015) three phases in building a sound data collection, namely pre-data collection, during data collection and post data collection phases. The initial phase was a desktop data collection planning process. It included defining goals and objectives of data collection, sourcing relevant key organisations and delimiting wards. The phase also involved drawing up of sample sizes, putting in place data collection tools and drawing up checklists. This was followed by applying for research clearance, drawing a data collection work plan and making appointments.

The second phase started by getting research authorisation from the Ministry of Agriculture and the District Administrator, as well as from the paramount chiefs. AREX was visited for food crop production figures and CA project objectives and design. A pre-test of the farmers' questionnaire was run among five farmers and the questionnaire was cleaned for the actual survey. Questionnaires were administered to farmers with the help of three research assistants, as well as key interviews and focus group discussions. The post data collection phase involved data cleaning and ensuring completeness, accuracy and reliability of data collected. The research used both primary and secondary data sources. For secondary data, official documents were reviewed while key informant interviews, questionnaires and focus group discussions were used to collect primary data.

Table 3.1: Research matrix

Research Objective	Data collection Methods	Data Analysis	Target group	Assumptions
-Characterise the nature of CA project in Chivi district	-Official documents review -AREX -CARE International, Christian Care Logical framework review -Key informants interviews and questionnaires	-ATLAS.ti 8 's data coding and narratives organisation	-AREX -NGOs	-CA project design used in Chivi is not suitable for the community
-Evaluate adoption of CA in Chivi	-Official documents review -focus group discussions -questionnaires -key informant interviews	-SPSS, IBM Version 22.0- for capabilities such as trend analysis, cross tabulation, chi-square tests and correlations. -ATLAS.ti 8 for capabilities such as coding and themes formulation	-AREX -Farmers -Community members -NGOs	-The adoption of the CA is low
-Compare and evaluate food crop yield per hectare under CA and conventional agriculture in the District	-AREX documents -Questionnaires -Key informant interviews	-SPSS , IBM Version 22.0- for capabilities such as trend analysis, cross tabulation, chi-square tests and correlations	-Agriculture, Research and Extension officers, Farmers	-The adaptation strategy is not efficient
-Assess the socio-economic impacts associated with CA in Chivi	-Questionnaires Key informant interviews Focus group discussions food crop yields review agricultural returns review	-ATLAS.ti 8 for capabilities such as data organisation, coding and themes formulation -SPSS , IBM Version 22.0- for Trend analysis, cross tabulation	-community and community leaders -AREX -Farmers -NGOs	-CA has made a huge social; impact on Chivi community CA strategy is not economic viable

3.3.1.1 Secondary data

Secondary data

Secondary data was elicited from the AREX and CARE International. Data on food crop yields such as maize and small grains was targeted. This data was sourced through face to face, unstructured interviews and documents review. Food crop production was analysed by comparing production trends under conservation and conventional farming at district level and this also showed the contribution of CA to Food security. Hence cushioning farmers and the community from the climate drought risk. Agricultural production costs and gains associated with CA were assessed at a plot level. The Chivi District CA official documents were also examined to determine the nature and characteristics the project. This helped to establish the CA project design in Chivi. Cooperative for Assistance and Relief Everywhere (CARE) and Christian Care's project Logical Framework (Log frame) and reports were reviewed and used to get an insight into the project. The study also examined community roles in project plans and implementation.

3.3.1.2 Primary Data

3.3.1.2.1 Key informant interviews

This study used the VLIR-UOS (2019) structured interview checklist to establish the conceptual framework design of the CA project in Chivi (Appendix 2). CARE International and Christian Care Monitoring and Evaluation officers were targeted. This interview schedule sought to assess the project design using the HIVOS (2015) Theory of change principles, thus the desired change, analysis of the system and the current situation, mapping pathways of change, the assumptions underlying our theory of change, strategic options and process. These interviews established the nature of the CA project in the study area as well enabled the evaluation of the project against its objectives of the intervention, emerging understanding of good adaptation (theory of change) and the baseline which is the initial situation of Chivi District before CA.

CARE, Christian Care and AREX officials were also interviewed using face to face open ended question interviews, refer to Appendix 3 and 4. This helped the research to establish food crop production trends, costs and the levels of project buy in by the community. The interviews also established the level of community involvement and gave insight into the effectiveness and sustainability of the project.

3.3.1.2.2 Household questionnaires

The questionnaires were administered to Chivi community household heads. 140 household heads participated in this survey. The questionnaire was designed based on the Sustainable livelihoods framework (DFID, 1999). The questionnaire infers information on adoption and socio-economic impact of CA using sustainable livelihoods indicators such as human capita, social, physical and financial assets. The four segment questionnaire was used to assess the appropriateness of the project design, efficiency, effectiveness, buy in and the socio-economic impact (Appendix 1). The first section dealt with human capital, this included household head's personal information, followed by the household social assets, then physical and financial assets under one section. The last part of the questionnaire focused on CA, its characteristics, adoption and efficiency.

3.3.1.2.3 Focus group discussions

Focus group discussions entails gathering of people of same experiences to discuss a particular topic of interest. Nyumba *et al.* (2017) define focus group discussion as the widely used technique in a qualitative research to gain an in depth understanding of social issues. The research conducted focus group discussions in six purposively sampled wards. These wards were sampled from the 32 wards under study. Pre-arrangements were made with the Ward leaders to set up the groups. The participants were conveniently selected depending on their availability. In all wards the groups consisted of males and females, farmers and non-farmers. The discussions were held to determine the social adoption of the Conservation Agriculture in Chivi. They also helped to assess the impact the project has made to the community, refer to appendix 5. These discussions were done with the help of research assistants to enable maximum data capture. The research matrix summarises the research data collection methods which the researcher used and the targeted participants.

3.4 Ethical considerations

Throughout the study, the researcher conformed to ethical issues. The research proposal was presented to the University Higher Degrees Committee and passed. The University Research Ethics Committee also cleared the research before data collection and permission was sought from gatekeepers in this case, the Chivi District administrator, Department of Agriculture Extension Services, NGOs Program directors, Chiefs and village heads. Participants volunteered to take part in this study and no force or trickery of any kind was used, refer to Appendix 1. Their consent was sought before participation. Information provided by participants was treated with confidentiality and names of participants were not captured.

3.5 Data presentation and analysis

A number of techniques and software programmes were used to present and analyse data. These included the ATLAS.ti 8 to evaluate the Conservation Agriculture project and its adoption by Chivi community. SPSS capabilities such as trend analysis, cross tabulation and Chi-Square tests, were used to compare food crop yields under conservation and conventional agriculture in the District. The relationship between productions under both systems was also assessed. To assess economic impact of the CA from a plot level to the whole community, agricultural returns and spill offs in development were used. Subsequently ATLAS.ti such as Co-code Doc Table for numeric analysis, Network diagram and Report tool were used for visual and text analysis respectively. Data was then presented in graphs charts and themed narratives.

3.5.1 The Logical Framework review

To evaluate the CA project design for Chivi District, the VLIR-UOS (2019) structured key informant interview schedule was used, refer to Appendix 2. The main NGOs operating in Chivi's CA project are funded by the European Union and follow a logical Framework in planning, monitoring and evaluation, hence to evaluate the project designs, the project logical frameworks were reviewed. However, literature on development of adaptation evaluation frameworks, note the straight jacket nature of the framework and its failure to capture the views of the stakeholders as well as measuring the unintended impact (van

Es *et al.* 2015; Bene, 2015 and Thomet and Vozza 2010). The VLIR-UOS (2019) structured interview schedule allowed this study to analyse the background and future of the project. It gave the logic and rationale behind the focussed change as well as capturing its shortfalls. The Logical Framework review findings were analysed using the ATLAS.ti 8 software and the project design was characterised and evaluated against its objectives and baseline data and perceived standards.

3.5.2 Key informant interviews and Focus group discussion data

Supporting data from key informant interviews and focus group discussions to establish CA project adoption and its impact in the community was analysed under various related themes using the ATLAS.ti for Windows. The findings were compared with the Log frame reviews, related theories such as Theory of change, Sustainable Livelihoods, and VLIR-UOS (2019) framework, United Nations poverty datum line and United Nations Hyogo Framework 2005-2015. Data was presented on its own and used to support results of other data sources.

3.6 Data presentation

Data was presented in the form of graphs, charts, tables and Microsoft Office Excel 2010 computational worksheets. The worksheet tables explicitly showed the calculations, statistical processes and results. Descriptive statistics, such as frequencies, standard deviations, percentages, Chi-square and mean were presented in graphical form for vivid visual effect. Qualitative data was presented in a narrative form. Data analysis methods used in this study will be further explained in detail in the findings chapters.

3.7 Summary

This chapter gave a description of data collection processes, theoretical framework and analysis techniques which were followed by the study. The broad objective of this study is to examine CA project as a drought adaptation strategy. Key informants and focus group members were purposively sampled, while farmers were selected using the multi-stage random, purposive and systematic sampling. The CA project design was evaluated using the VLIR-UOS (2019) Logical Framework review schedule, Food crop production trends were examined using SPSS capabilities. While the CA technological adoption and the impact of CA on Chivi community was evaluated using the ATLAS.ti 8 software.

This study unveiled the nature of CA project practiced in Chivi. It also revealed how CA has been adopted in the district, CA’s socio-economic impact and food crop production levels under CA and conventional system. Subsequently a model for effective adaptation to drought was drawn.

CHAPTER 4: THE NATURE OF CONSERVATION AGRICULTURE PROJECT IN CHIVI

4.0 Introduction

CA is an innovative and sustainable technology which ensures soil and water conservation through its principles of minimal soil tillage, mulching, crop rotation, efficient and timely use inputs has gained momentum in different parts of the world (FAO, 2019). In southern Africa, the CA system has been researched and promoted by a number of organizations. Conservation agriculture has been hailed as a potential solution to crop production problems facing smallholder farmers in sub-Saharan Africa (ZCATF, 2009). In southern African countries such as Zambia and Tanzania, the use of CA by smallholder farmers has recorded immense success. CA system annual farm level gross margins increased by 240 to 400% per hectare in Zambia and rose from 34 500 to 213 050 Tanzanian Shillings per hectare in Tanzania (FAO, 2011 and Shetto and Owenya, 2007). Conservation Agriculture in the Zimbabwean context has yielded mixed reactions. However the feasibility of the CA model on smallholder farms in light of the complex biophysical and institutional spheres in which they operate remains questionable (Nhodo *et al.* 2010 and Mango *et al.* 2017.) In Chivi district the project has been marked by social tensions, low adoption and even withdrawal (Pedzisa, 2016 and Gukurume *et al.* 2010). This chapter seeks to characterize the nature of CA project in Chivi.

4.1 Results and discussion

4.1.1 The general characteristics of CA in Chivi

To establish the characteristics of CA Chivi District, the official documents of major organisations working on this project, thus AREX, CARE and Christian Care were reviewed. Three CA Project Coordinators were interviewed using the structured interview schedule, 16 AREX extension officers were interviewed using the open ended unstructured interviews, 140 household heads and 90 Chivi community members participated through questionnaires and focus group discussions respectively. The results revealed both strengths and weaknesses within the project.

The findings from key informant interviews described CA project in Chivi as a “climate smart agriculture system”, designed to suit low rainfall and high temperatures experienced in the District, which is located in the dry region. The CA model has a high precision in terms of nutrient application and has a high water efficiency as it incorporates water harvesting techniques in form of basins and mulch hence it is very efficient in terms of moisture conservation. CA seeks to maximise yields from the minimum input by the poor farmers in the District. It also minimises soil tillage and conserve the soil for sustainable agriculture. CA‘s capabilities of conserving soil nutrients and soil moisture makes it ideal as a drought adaptation tool. CARE and Christian Care officials conceded that the project implemented in Chivi is a basic model of basins and mulch integrated with ‘in situ’ water harvesting structures. Its difference from other CA models such as the mechanised model is that it is simple, it can be practiced by poorest of the poor. Chivi comprising of poor smallholder farmers, an affordable technology would enhance drought adaptation in the community (ZCATF, 2009). Pedzisa *et al.* (2015) and Mango *et al.* (2017) support these findings and inform that CA project is targeted for the poor. The key informants’ findings also revealed that to cut high labour demand CA is now being mechanized to the ripper system. This replaces the permanent planting basins with furrows.

4.1.2 CA Principles

Key informant interviews revealed that CA project has been implemented under three main principles of zero-minimal tillage, mulching and crop rotation, complimented by short-season variety small grains and maize, appropriate use of fertilizers as well as timeous crop management.

4.1.2.1 Zero to minimal soil tillage

According to key informants, in a bid to conserve soil nutrients in the poor sand loamy soils of Chivi, the initial CA model engaged the zero tillage through the use of permanent planting basins. The model is popularly known as (Dhiga udye) a Shona translate to “Dig to eat”. 30cm by 30cm planting basins are dug buy a hand hoe as permanent grids for planting (Figure 4.1). A space line 60cm to 75cm separates the basins and an average of about 17 780 holes are dug per hectare. According to key informant interviews findings, this package is specifically for agro-ecological region five and spacing decreases in wetter regions. Plants are then planted at a plant line of 15 cm, mid-way of the plant basin, the remaining 15 cm form the rain water dam. A maximum of 3 plants are seeded per basin but pruned to two plants after germination.

Figure 4.1: Planting Basins (Source: Fieldwork, 2017)

Christian Care is still using this model in its three Wards in Chivi, while CARE international uses this model and is in the transition phase to the ripper tine model which is an upgraded version advocating for minimum soil tillage. According to key informants the ripper tine is a mechanized technique which works the same way as the conventional plough system, the difference is that unlike the plough discs, the ripper tines produces shallow furrows. Basins are very unpopular with Chivi community, both questionnaires and focus group discussions spelt the labour intensiveness of CA. Chivi community has even dubbed this principle (Dhiga ufe) a Shona translate to “Dig and die” (Chineka, 2019).

Labour intensive model adds burden to farmers who are mostly farmers and are already overburdened in their gender roles (Chineka, 2016). The AREX and NGOs also acknowledged the labour associated with the basin system, and contextualised their transition to the ripper tine system. CA in the 12 wards under CARE International was done in phases.

According to CARE officials, the initial phase SIPR1, which operated from 2008-2013 targeted the poor farmers and used the manual based basins (Dhiga udye) is still being used in some wards, where farmers cannot access the new technology, such as ripper-tines and in ward 10 under Heifer as well as ward 26,27 and 28 under Christian care. NGOs established demo plots where they demonstrated and trained farmers technical skills of CA. Farmers in turn established baby demo plots on which they work in groups of 15-30 farmers. Digging of basins is only done in the first year of the project. The basins conserve soil, increase efficiency of fertilizer application as well as conserve soil moisture. However digging of basins over 0.1 ha demo plots revealed that this principle requires a lot of labour and it became unpopular among farmers. Focus group discussions showed that farmers are not ready to implement zero tillage on their own farms. This led to the establishment of the mechanized CA .The CARE International second phase SIPR 2 of 2013 introduced the use of ripper-tines

Ripper-tines are more or less like conventional plough farming practiced in the area. Ripper tines are attached to the plough and drawn by cattle and donkeys similarly to the plough system. The ripper tines due to its narrow chisel points has low or minimal tillage as compared to the plough system. This makes the tool maintain soil and water conservation ideal in the light of drought. The ripper tines are used by CARE under its SPIR 2 phase, whereby farmers have to buy their own farming tools from agro-dealers. The questionnaire administered to CA farmers listed ripper- tines as a challenge (Table 4.1). This creates a challenge to farmers who are already economically unstable. CARE officials also confirmed these findings and added that farmers who cannot afford the ripper tines use the basin system.

Table 4.1: Conservation Agricultural techniques and challenges

CA challenges	Frequency	Percent
cost of fertilizers/inputs	58	77.33%
Machinery	1	1.33%
markets not available	5	6.67%
Mulching	4	5.33%
requires labour	2	2.67%
shortage of ripper-tines	2	2.67%
sometimes burn crops	3	4.00%
Total	75	100.00%

The use of ripper-tines reduced labour in CA. According to CARE, farmers even increased their acreages from the initial 0.1ha to 0.2ha and from 18 mother demo plots to 180 baby demo plots. The questionable issue in this CA plots extension is that farmers are still working on demo plots in groups for over a decade now.

4.1.2.2 Mulching

Key informants interviews indicated that mulching involves covering of the soil to reduce loss of soil moisture to evaporation. After harvesting, farmers are supposed to use crop residues or grass to cover the soil. Soil cover has to be permanent, to reduce runoff and evaporation. Soil water retention is ideal in boosting agriculture, which in turn reduce the effects of drought and other climatic risks (ZCATF, 2009 and Mazvimavi *et al.* 2010).

Farmers also use the same crop residues to feed cattle in the dry winter season when pastures are dry. Chivi District has 28 communal wards, 3 resettlement wards and one small scale commercial ward. The focus group discussions showed that CA project is being practiced in the communal areas, where the land is communally owned and its management is entrusted with the chiefs or kraal heads. Besides land being communally owned at household level, the family plots belong to patriarchy (Chineka, 2016 and 2019). Fathers own the family plots which will in turn be subdivided among their sons upon marrying, women do not own, but manage the plots and in case of widows the land ownership will be passed to their male sons, when they marry. Female divorcees own small plots which their brothers or fathers will cut from the family plot upon their return.

NGOs operating in Chivi confirmed being aware of land ownership and gender dynamics. Interview with CARE established that the organisation is still negotiating with traditional chiefs to allocate land to women the same way they give it to men. Tenaw *et al.* (2009) notes that structure of land tenure and lack of proper land ownership negatively affect agricultural productivity. Land ownership could be affecting some principles of CA such as the basins and mulching and subsequently impact on the effectiveness of CA as an adaptation tool.

Figure 4.2: Mulching in Chivi (Source: Fieldwork, 2018)

Chivi community practices mixed farming that is crop husbandry and rearing of livestock. Livestock according to focus group discussions is a sign of wealth and a great cushion in terms of injecting income during tough times such as drought period. With the symbols attached to livestock, it goes without saying that pastures are a valued resources. During the dry winter season, farm fields crop residue become community pastures, hence the domain of change with regard to mulching is operating not only in challenging trajectories but even defies the social contracts pertaining land ownership creating social tension not ideal in drought risk adaptation. Nhodo *et al.* (2010) and Gukurume (2013) also noted a social alienation of CA farmers by non-adopters in Chivi.

4.1.2.3 Crop rotation

Crop rotation is the other CA principle practiced in Chivi. Focus group discussions and key informant interview results showed that crop rotation is one of the major principles of CA in Chivi. Farmers rotate cereal and legumes across farming seasons to build and maintain soil nutrients. Crop varieties such maize, and sun hem are rotated with sorghum, cow peas and ground nuts. Crop rotation is done to fix soil nutrients and aeration. Maize is the staple crop in Chivi and farmers prefer it for food security reasons and also its readily available market. AREX and NGOs promote small grains for their suitability and resilience to dry seasons and recurrent drought experienced in this community. However the use of the small grains is one component which is unpopular with the community. Small grains were listed by Chivi community, as one of the reasons for not adopting the project.

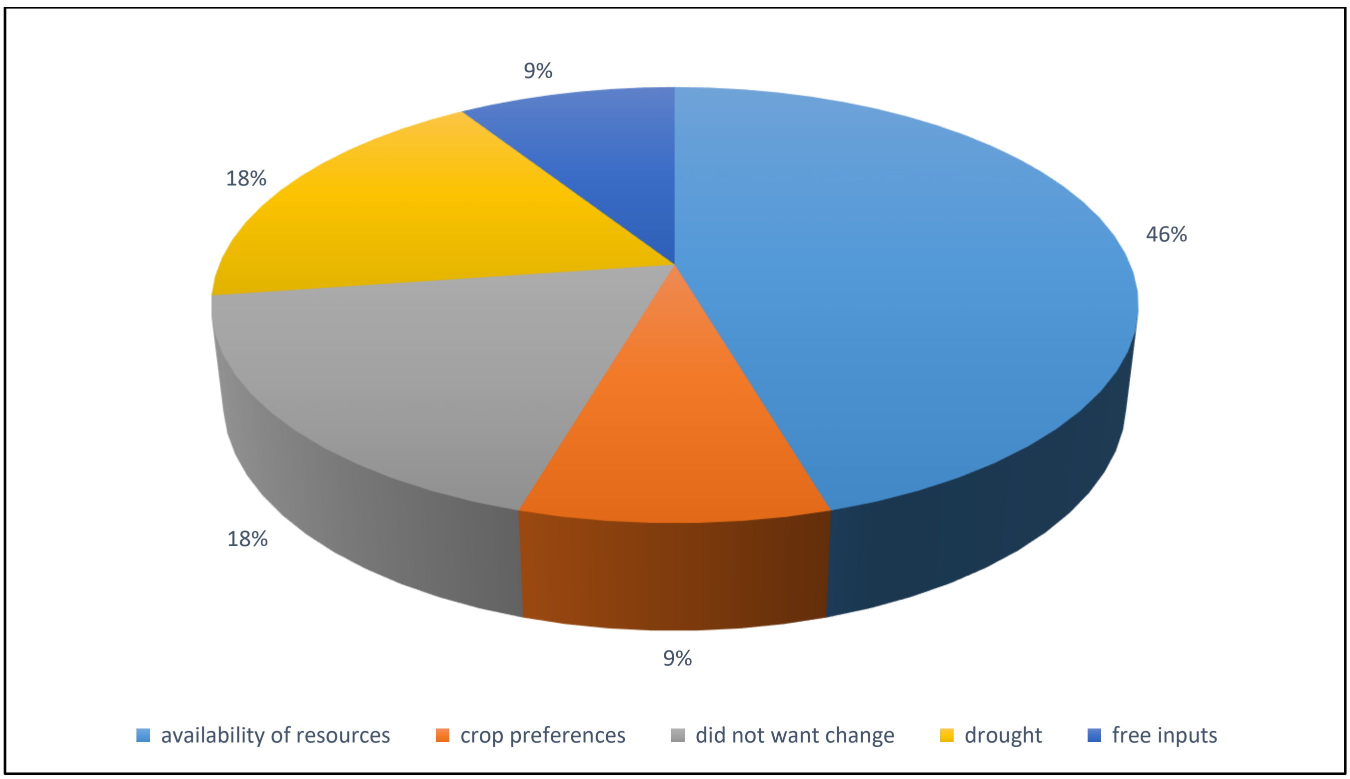

Figure. 4.3 Reasons for not adopting CA

About 9% of the focus group discussants did not join the project of CA because they did not prefer use of small grains, see Figure 4.3. According to Moyo (2018) and Phiri *et al.* (2019) small grains are suitable for drier regions such as Chivi. AREX officials also supported this view and conceded that small grains such as sorghum and millet are mainly used in CA than maize and other crops.

4.2 CA plan of activities in Chivi

CA activities involve digging basins, ripping, application of basal fertilizer, planting, weeding, top dressing and post-harvest management which include mulching. The activities run throughout the year (Table 4.2). Chivi district is practicing CA alongside the conventional plough system as well as livestock rearing.

Table 4.2: Chivi CA Project schedule of activities

ACTIVITY	0	N	D	J	F	M	A	M	J	J	A	S
Winter weeding						■	■	■	■	■		
Land Preparation (digging basins, ripping, digging furrows)	■									■	■	■
Application of basal fertility amendments (manure, compost, lime, compound fertilizer)	■									■	■	■
Planting	■	■	■									
First weeding					■	■	■					
Second weeding			■	■								
Third or final weeding					■	■						
Application of top dress fertilizer			■	■	■	■	■	■	■	■	■	■
Post-harvest management									■	■		

It is also important to note that weeding is done three times as compared to once under conventional agriculture. The winter weeding coincides with the period when communal farm plots will be used as pastures. This creates a conflict with the conventional system of agriculture in Chivi. Household questionnaires and focus group discussion participants also raised CA as labour intensive. However CA is said to be labour intensive in its first years (Mazvimavi *et al.* 2010 and Thierfelder *et al.* 2015). NGO key informants supported this view.

Chivi is a dry area, characterised by droughts and high moisture deficiency (Dube, 2008; Mudzonga, 2012 and Chineka, 2016). Principles used by CA are much in line with the area's climate. The project identified the principles which relate to environmental conditions of Chivi. The use of basins to assist poor farmers in as much as it was a noble idea, farmers in Chivi lack financial assets but they do have livestock. This is supported by Mavedzenge (2006) who notes that communal farmers account for 89% of Zimbabwean cattle. Findings from household questionnaires revealed that Chivi farmers have large herds of donkeys, with 48.6% of the respondents having more that eleven donkeys. Other popularly owned livestock included cattle, with 15.7% of the farmers having at least eleven cows and poultry, with 22.1% of the farmers having at least eleven birds. Therefore farmers practice mixed farming thus crop and livestock husbandry.

Livestock is not only a symbol of wealth in Chivi but an important safety net during lean seasons. CA principles such as mulching and basins conflict with livestock production in Chivi. Nhodo *et al.* (2010) and Gukurume (2013) noted conflicting knowledge systems on mulching crop residues which should provide permanent soil cover are vital stock feeds in dry seasons. CA's basin system also conflict with livestock rearing, basins trap and injure livestock. CA farmers are conflicted between the two farming systems. According to the National livestock policy (2004:14)

"Small holder farmers must become more commercialized and become progressive livestock farmers rather than livestock keepers".

Therefore these CA principles also contradicts the Zimbabwe National Policy on livestock.

4.3 The project design of CA in Chivi.

Project design refers to the logical organisation or structural framework of the project. It is the strategic organisation of the concept, ideas, goals and resources, this involves planning from the first phase of a project cycle, where a problem is identified, possible solutions, stakeholders, its context, risks, assumptions, goal, objectives, outcomes and activities and systematically and documented for proper project implementation, monitoring and review (Hivos, 2015). Poor project design is often associated with project failure.The VLIR-UOS (2019) Theory of change (Toc) structured interview checklist was used to establish the framework design of the CA project in Chivi. The VLIR-UOS (2019) ToC structured questions sought to assess the project in light of the Theory of Change for transformative change and mapping of pathways, the theories which shape this study. The Theory of change has also been adopted by NGOs such as CARE in its project frameworks. CA project frameworks were reviewed to get a better understanding of the nature of the project as a drought adaptation tool.

4.3.1 CA‘s main goal and objectives

The key informants’ interviews showed that the main objective of CA project in Chivi is the establishment of a climate smart agriculture system to suit low rainfall, drought and high temperatures in Chivi district found in agro-ecological zone five (Figure 4.4). Agro ecological regions are the land use units delimited in terms of their climatic conditions such as the mean annual rainfall (Mugandani, 2009). Hence Chivi was targeted because of low rainfalls and recurrent droughts. NGOs also listed the need to maximise yields from little inputs, thus increasing efficiency of agriculture. Maximising of yields from minimum inputs was to match the needs of poor farmers in the district. The high poverty levels were also supported by household questionnaire findings which revealed 69.3% of the participants had monthly incomes below the World Bank poverty datum line. The other objective listed was to minimise soil tillage and conserve soil for future generations.

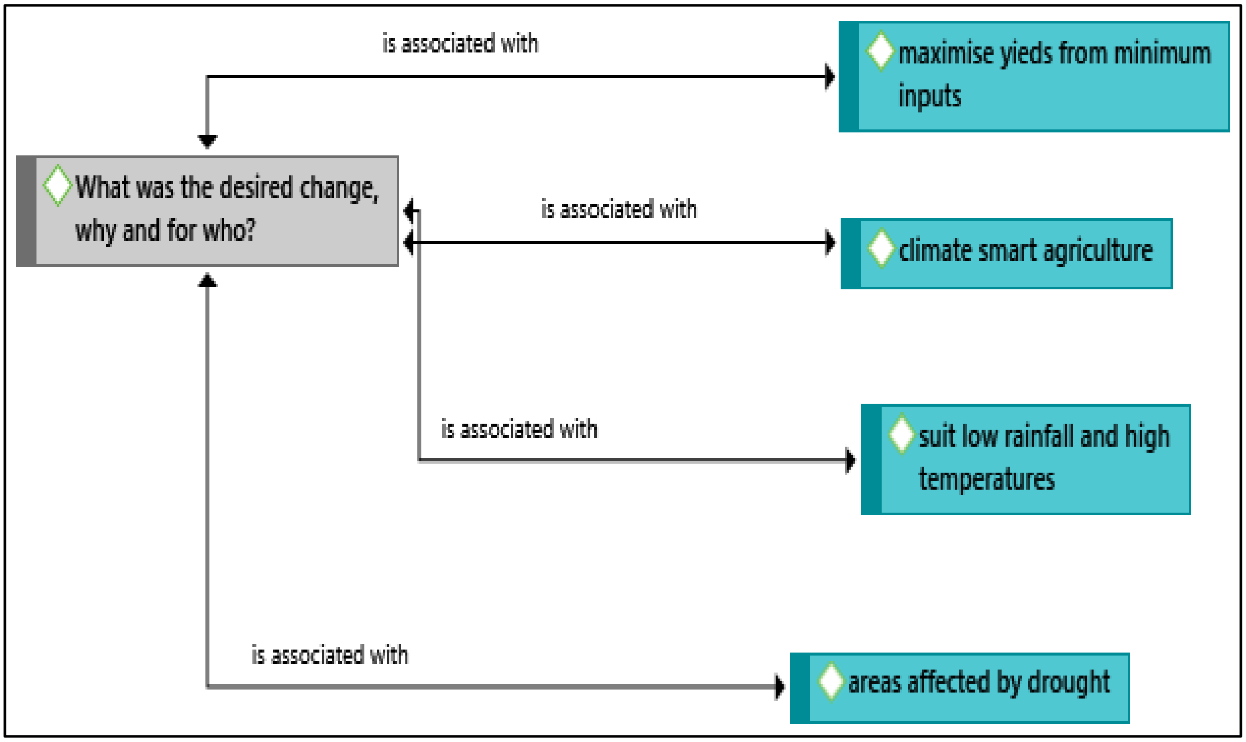

Figure 4.4 CA project objectives

Both CARE and Christian Care had the same objectives except for drought, which was not listed by Christian care.

4.3.2 The background of the problem and its causal link

The logical framework of CA showed that the situation prior to CA was characterised by inadequate resources by farmers leading to failure to acquire adequate agricultural inputs, knowledge gaps on conservation and maximizing yields from minimum inputs. This is supported by Mazvimavi *et al.* 2010; Nhodo *et al.* 2010 and Mugandani and Mafongoya (2019). Key informants revealed that farmers wasted inputs such as fertilisers by spread application on extensive plots under conventional agriculture. Soil moisture was lost as well as top fertile soil due to tilling using ploughs and tractors. Farmers without draught power would fail to plant their crops on time. Drought and hot temperatures affected yields under the conventional farming system. The causal links identified are that all these problems challenged livelihoods of Chivi community. They also affected community resilience to drought and other related climatic risks. This also linked to food insecurity of the community and exacerbated poverty.

4.3.3 Problem analysis: Problem context and scope

The scope of the problem as phrased in NGOs logical framework contextualized the general problems which faced agriculture in Chivi. They noted that Chivi district has been hard hit by persistent droughts since time immemorial; coupled with the economic hardships facing the farmers the situation becomes dire for their livelihoods. Political polarization of the two major political parties in the country has seen lack of investors' confidence and as such the inflation rate in the past years has soared and not sparing our farmers. Approximately 80% of the farmers are in the dry land and have no access to irrigable plots. Of the little irrigation in the district they ration water use especially in October to December to allow other activities like watering livestock.

Major problems faced by target groups noted were draught power which has been a major cause for concern to the rural farmers, unavailability of inputs as well as knowledge gaps to mitigate the persistent droughts. Having identified these challenges in context, the scope picked the need to assist farmers planting drought tolerant crops like small grains and practicing conservation methodologies like CA and the use of mechanized CA that focuses on the use of ripper tines for minimum soil tillage. While literature (Mazvimavi *et al.* 2010; Thierfelder *et al.* 2010 and Makuvaro, 2014) supports the use of small grains to mitigate the effects of drought, the effectiveness of CA as a drought adaptation tool remains questionable (Nhodo *et al*. 2010; Gukurume *et al.* 2010 and Michler, 2019).

4.3.4 Broader contextualization of the problem, environmental and socio-economic issues

Problem analysis party of the Logical frameworks tried to establish the broader context of the problem, its link to environmental issues and socio-economic issues such as gender and it noted that indeed the issues to do with food security are a burden to children and women. Most men migrate in times of drought seeking employment and leaving their spouses and children vulnerable. However the questionnaire and focus group discussion noted that there is not much difference between male and female population in the area. The levels of malnutrition and stunted growth of children during the first 1 000 days of human life were also noted to be high in the district, stunting was at 31% according to

ZimVAC (2014) survey. Reference to national or external surveys highlighted the use of and reliance on secondary data by these NGOs. The solution to remedy for nutritional gap as per the logical frameworks was to grow small grains and construction of small weir dams coupled with nutrition gardens to supplement the nutrition of the farmers. It is important to note that NGOs do not operate CA project in isolation, it has sister projects to address the other domains of change which if not addressed might affect the outcomes of CA. Heifer an NGO operating in ward 10, even run Pass it on as its main project, a livestock initiative to ensure farmers have the much so needed livestock which can be easily be liquidated for cash or used for draught power and its byproducts.

4.3.5 The stakeholders and their role in CA project

Both NGOs' logical frameworks identified farmers and their farmers groups as the direct beneficiaries of the project. In forming farmers' groups, farmers are bound by constitution and this facilitates uniform production, discounts when they are purchasing agro inputs and labour and techniques sharing. AREX Officers are a government arm and offer technical support to the farmers, software component trainings, motivation, leadership and monitoring of the farmer groups. They co-ordinate with partners such as NGOs. NGOs complement Government efforts in the districts and ward assisting farmers. While Agro dealers ensures the availability of agricultural inputs to farmers. Cooperating partners such as NGOs in the district Christian care, CARE international, Heifer, Afri-care, government line ministries at district and ward level individual farmers, farmer groups and agro-dealers such as Farm and City Centre and Masvingo Farm supplies were the partners or stakeholders identified.

All stakeholders assist in achieving the desired goals following a participatory approach. A stakeholder is defined as an individual, group or organisation affected or might be affected by a perceived decision, activity or outcome of a project and this is a continuous process (Usmani. 2019). The article notes that stakeholder identification become more challenging when the public is involved, hence need for wider consultation and drawing of their influence on the project. Lack of public consultation and failure to map the community's influence on CA project was raised in Chivi (Nhodo *et al.* 2010 and Pedzisa, 2016).

NGOs refutes this and showed that analysis of the role of stakeholders was done in the project formulation process and their participation, reflection and discussion noted that at design stage. A feasibility study was done and the findings informed proposals writing. Communities' needs were identified through ward disaster risk reduction plans which are kept filed by the District Administrator. These plans are continuously reviewed on yearly basis to update them. At the inception stage for the project, the stakeholders were involved and they participated joint monitoring. The District Food and Nutrition Security Council was also key at all the stages of the project from inception to date. A mid-term evaluation conducted was participatory at both district and ward level and all stakeholders were taken on board. However their use of secondary data sources supports the queries raised on the role of the local community in CA (Gukurume *et el.* 2010 and Pedzisa *et al.* 2015). Focus group discussion participants also showed a passive role in CA.

4.3.6 Project feasibility analysis

Project feasibility analysis is defined as a detailed study of how the project can be successfully completed. It allows determining and organizing all necessary details for implementing a viable project (Ahmed, 2019). The log frames of NGOs showed that the available know-how, capacities and the project's capture of stakeholders' interest was assessed. Findings established that the CA project is complemented by government stakeholders who have the technical know-how of the project. NGOs also recruited specialists with experience and some who have previously worked in the government. There was also complementarity between NGOs CA staff and staff in government line ministries such as AREX, Health, Women affairs and Local government. The District Food and Nutrition Security Council has all representatives in the district who actively participate in the project. The project also uses information from national surveys such as ZIMVAC which are done on yearly basis and they give a reflection of the project.

On capacities CARE has built capacities in its initial phase supplying all inputs to farmers, in this second phase support has been withdrawn in terms of inputs to cut donor dependency and ensure sustainability of the project. Village savings and lending are financing the project thus ensuring a good exit strategy for sustainability after weaning the project. The log frames were not much elaborative on the targeted communities.

Information on Communities was about capacities. It showed that communities are equipped with fruit and vegetable production which are preserved for use during lean and drought seasons. However communities are not homogenous and neither static nor ignorant. Vemuru and Tesfaye (2018) note that communities are keen on projects they are fully engaged on. Communities react to a problem that impact their society and is labelled a social problem by them (Mooney *et al.* 2017). Feasibility analysis in the NGOs log frames is silent on exploring beneficiaries' societal values, interests and blending local knowledge with the project's ideas.

4.3.7 Mapping pathways of change from the desired change and domains of change

Pathways of change refers to projections of the envisaged change process drawn from the known current situation, views and beliefs of how change should occur. This is mapped backwards from long term desired change by highlighting what needs to change for the desired change to occur (van Es *et al.* 2015).The pathway of change as noted by NGOs has to begin at a household level cascading to the community. Peers form sphere of influence in this domain, hence they noted peer to peer strategy as the best in implementing change for sustainability. The project's key risks identified include drought, cyclones and economic meltdown. Of the three economic meltdown had the highest score followed by drought on the probability of occurrence. The potential impact of these risks being erosion of the gains of CA, which might even lead to sourcing of more funds. The key issue to note in this is that drought is identified by the project as a risk to CA yet CA is also listed as an adaptation strategy to drought.

Key informants also added on this contradicting pathways and domains of change, they noted drought as a driver of CA in Chivi and listed it as one of the project's objectives, however they view recurrent drought as a threat to the gains of CA. Focus group discussions also picked up that during drought periods both CA and non-CA farmers suffer drought effects. This again contradicts Michler (2019) 'assertion that CA does best during periods of massive soil moisture deficit. Project log frames also track change process through baseline surveys, mid-term evaluation and end line surveys. Reports both in narrative and statistics, success stories, photo galleries and testimonies of beneficiaries map the pathways. Monitoring and Evaluation teams consolidate information in the database. Key factors that influence the pathway of change both positively and negatively need to be identified and be involved for mitigation of negative forces and buildup of inclusive rural projects (van Es *et al.* 2015). While the mapping of change process is challenging, there is a need of striking a balance between over detailed maps and sketchy, superficial and quick approaches (Brown, 2018). CA in Chivi has been accused of cosmetic bottom up approaches and CA adoption remains low, with some CA farmers withdrawing (Pedzisa, 2016 and Nhodo *et al.* 2010). Effective tracking of change should cover all spheres of influence and integrate local values and beliefs to avoid reproduction of stereotype thinking which does not add value to the project.

The CA project design is well elaborated and comprehensive. It meets the design and implantation requirements of the Zimbabwe Conservation Agriculture Taskforce guide (2009). The guide was established by FAO, various NGOs and Ministry of Lands and Agriculture for ensuring uniformity in the standard of operation. The main targeted group was the poor communal farmers and vulnerable communities which, the Chivi CA design did. The project design also follows the CA principles agreed upon such as the use of a minimum cost system. The CA project design is also in line with the FAO's vision and objectives. FAO's vision is to ensure

"*a world free from hunger and malnutrition, where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable way*" (FAO, 2015:8).

It also addresses the organisation's objectives such as improving efficiency in the use of resources which is crucial to sustainable agriculture and to conserve, protect and enhance natural resources.

However the CA design is not elaborative enough on local stakeholder roles and needs prioritization, social and gender change domains. Analysis of the role of stakeholders in the project formulation process, their participation, reflection and discussion revealed that at design stage, a feasibility study was done and the findings informed proposals writing. In this feasibility study the communities' needs were identified through ward disaster risk reduction plans which are kept filed by the District Administrator. This is supported by focus group discussions in which the community highlighted that the project leaders did not consult the community. They completely distance themselves from the ownership of the project. Nhodo *et al.* (2010) assessing the impact of CA on food security Chivi South noted conflicting interests and competing knowledge systems due to top down nature of CA. Use of the District Administrator's records to assess the needs of the community to formulate a new project is a clear top down approach which affects effective adoption of community projects.

The community is a heterogeneous entity with different worldviews and social challenges. Communities operate in a social domain sphere of influence, thus a society. According to Mooney *et al.* (2017) in these domains, communities react to a problem which impact on the society, thus a social problem. This social problem though it has no universal definition, it constitutes two elements, an objective social condition and a subjective interpretation of that social condition. This implies that community members have to identify the social condition and interpret it as harmful to their community for it to be a social problem. Hence what the government or external bodies might view as a problem in Chivi, might not be necessarily regarded as a social problem in Chivi. It is against this view that top down approach projects fail to get the much required community buy in. This top down approach even contradicts the theory of change, which FAO and EU projects are now pursuing, which places beneficiaries' beliefs and views at the center of the projects. Hivos (2015) defines theory of change, as the ideas and hypotheses people and organisations have about how change happens. It provides a guiding framework for intervening in social change processes. There is need to identify the community as a social sphere, in which a social change has to occur for effective drought adaptation.

CA project has a gender aspect in its design, and it realizes the importance of women in ensuring food security. The key interviews with NGOs informed that the CA project was more targeted on women. The project has a gender team which discusses sharing of labour to reduce burden on women. In as much as women's participation is crucial, Chivi women operate in a society with well complex gender dynamics. Nemarundwe (2010) examining the organizational framework within which decentralization is implemented in Chivi noted a complex community with complex authority structures conflicting jurisdictions and mandates. Chineka (2016) assessing gender vulnerability to drought noted well defined gender dimensions in Chivi. Gender dynamics in Chivi even influence land ownership as well as decision making, which are all controlled by patriarchy. These are the critical issues affecting adoption of CA and lead to dis adoption of the project and affect the effectiveness of CA as a drought adaptation tool.

4.4 The Institutional framework of CA in Chivi

The findings from key informant interviews with the CA project officials revealed that CA started in Chivi District around 1995 as a pilot project in Ward 10 managed by a regional organisation called SADAP, spread to Ward 21 under a United Kingdom NGO called ITDG in late 1990s. These NGOs aimed to harvest and conserve rainwater in agriculture. The project later on spread to the northern parts of the District such as Ward 11, overseen by Zvishavane Water Project, another local NGO. By 2003 CARE international and other several NGOs were now running CA in various districts of the country, sponsored by international donors such as USAID, The United Church of Canada, the Canadian Food Grains Bank, European Union and FAO. The lack of uniformity in the implementation of the project led to the government of Zimbabwe calling for a framework of operation. In 2008 a CA Taskforce was established to draft technical guidelines for CA implementation, monitoring and sharing of information (ZCTF, 2009). The CA Taskforce was also given the mandate to facilitate sharing of information and creating a rapport amongst NGOs and between NGOs and the government departments. It is important to note that lack of uniformity in CA is still evident in Chivi.

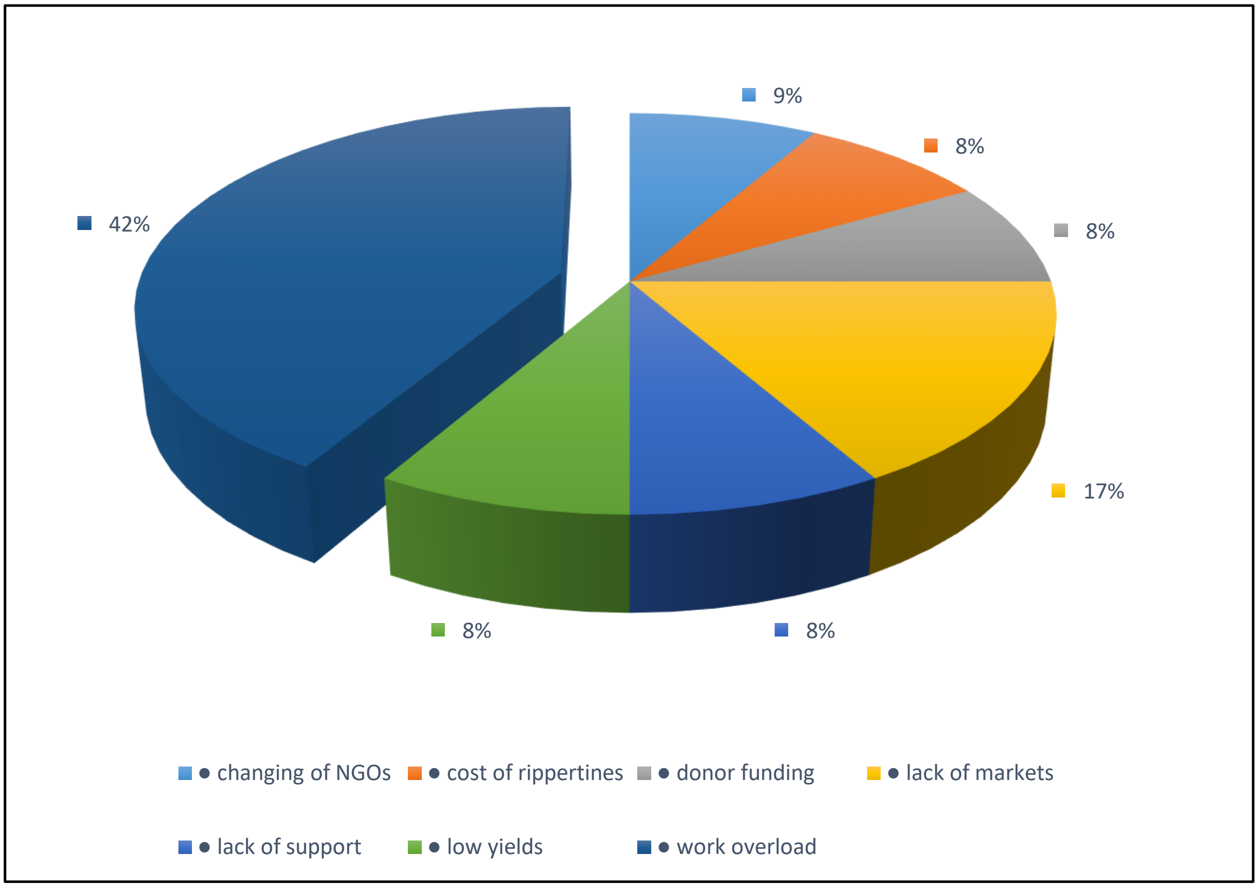

Figure 4.5: Challenges associated with CA in Chivi

Focus group discussants listed ever changing NGOs in the area as one of the challenges affecting CA (Figure 4.5).

Key informants findings also showed that CARE joined other NGOs such as Heifer, Action Faim and World Vision to work on CA in Chivi District in 2008. The NGOs started by a vulnerability assessment and chose the most vulnerable communities to climatic risks and poverty. However the log frames of the project reveal use of ZIMVAC assessments in mapping vulnerability. After nominating these vulnerable communities, they would then write a proposal for funding from donors. After sourcing the funds the NGOs would then approach relevant government structures, local government, thus the Provincial and District administrator as well as local kraal heads for the green light. NGOs would work with AREX to recruit farmers on voluntary basis. Farmers would in turn form co-operatives and get technical training.

4.4.1 Institutions running CA in Chivi

Focus group discussions and questionnaires revealed that there are several NGOs operating CA in Chivi District namely CARE, Christian Care and Heifer (Figure 4.6) below. These NGOs are operating in different wards.

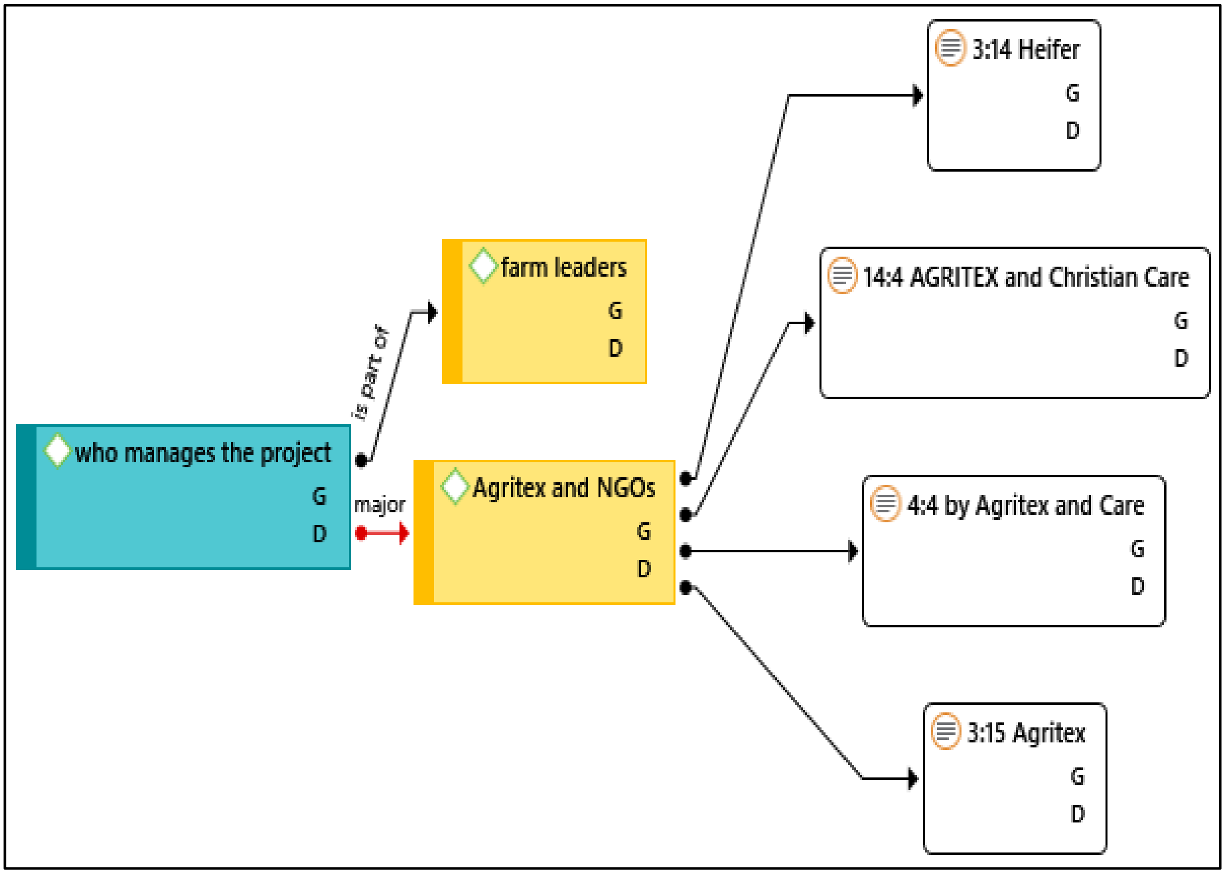

Figure 4.6: Institutions managing CA in Chivi

CARE is the main operator, working in 12 wards, Christian Care in three wards and Heifer in two wards. The main goals of these institutions are more or less the same, they range from empowering communities through sustainable livelihoods to ensuring food security, they have similar objective of maximizing agricultural production in fragile climates. They also target the similar population structures. However the NGOs work in an area as long as their budgets last, once they exhaust their budgets they roll out and another NGO takes over. This does not only confuse farmers but, derails the progress of CA, thereby affecting its effectiveness as a drought adaptation tool.

4.4.2 CARE International CA Framework

Key informants indicated that the organisation started working in Zimbabwe in 1992 in response to regional drought. The organization built up a drought mitigation program which was mainly in the form of drought relief. Chivi community members labelled vulnerable to drought, would receive monthly food parcels and free agriculture inputs as a disaster risk reduction measure. CARE International later decided to work on long term developmental programmes. It then engaged the Chivi communities on projects such as building small dams for water harvesting in turn locals would get food parcels for their labour. It also started building microfinance institutions and assist small businesses.

Due to erratic rainfalls and drought in the District, dwindling agricultural production and subsequent growth in food insecurity, CARE's overall goal expanded to empowering disadvantaged communities to meet their own basic needs, thus capacity building. Hence it moved away from being drought relief donors to help communities build their own sustainable livelihoods. This led to the introduction of CA in Chivi District under the CARE/World Vision SPIR 1 program, a five year project funded by USAID in 2008.

The main objective of the CA project was to provide a climate smart agriculture to low rainfall and high temperature areas such as Chivi District, which is found in Agro-ecological region 5. It also aimed to maximise agricultural yields from the minimum input by the poor farmers in the District as well as minimizing soil tillage in a bid to conserve soil for the future generations. The SPIR 1 program sought to address challenging causes of food insecurity such as low productivity, marginalization of small holder farmers especially women, access to markets and financial services.

The CA project under SPIR1 programme was modelled to graduate beneficiaries from their vulnerability and food insecurity to sustainable food security through the pathway theory. The pathway theory is a global change theory which addresses underlying causes of poverty to build more secure and resilient livelihoods. This was basically done through change of gear levers such as capacity, access, productivity, household influence and enabling environment. Hence the CA project had to address all the gears of change.

Giving of free inputs in the first phase of CA was pointed out by Focus group discussion participants as the main reason Chivi community adopted the project.

The second phase CARE project SPIR 2 framework was designed to wean off Chivi community from the donor syndrome pathway. The framework built capacity through three phases working simultaneously 1. Giving an initial push towards asset stabilization and ensuring food availability 2. Capacitate community through engaging pull strategies such as improving access to mainstream services, output markets and technologies. This would allow asset accumulation. 3. Building resilience to shocks ensuring food utilization. Farmers are no longer provided with inputs and have now established their own baby demo plots from the previous mother demo plots. This was confirmed by 77.3% of CA farmers who also listed high costs of inputs as one of the challenges they face. Pedzisa (2016)'s study also confirmed this and noted lack of free inputs as one of the reasons CA farmers are abandoning the project.

4 .4.3 Other NGOs working on CA in Chivi

Christian Care officials confirmed that the organisation operates in Chivi's three wards namely ward 26, 27 and 28. Christian care views CA as a tool to increase agriculture yield per unit, enhancing soil fertility through use of permanent planting grid, minimal soil disturbance, use of mulch and precision nutrition application. It started operating in Chivi in 2018. It took over from NGOs, such as Zvishavane water project, Afri-care, Action Faim and World Vision. Christian care started working on CA in 2009, sponsored by Act for Peace, Australia Aid. However it was operating in other districts in Zimbabwe. It moved into Chivi in 2018 under the sponsorship of United Church of Canada and Canadian Food Grains Bank. The Christian care CA framework is designed for dry areas to increase yields and improve lives in these communities. The changing of NGOs was noted as a challenge by CA farmers in Chivi. NGOs roll out when their budgets are exhausted, and new NGOs take over.

4.4.4 Government function in CA

Key informants from AREX revealed that their organisation is a government arm operating under Ministry of Lands and Agriculture and provides the technical support to the CA programme. Its extension officers who are distributed throughout the Wards, administer and offer extension services in the conventional agriculture system also work with agronomists of various NGOs working in the district to train farmers on the CA system. This includes preparing planting grids, application of fertilizers, timing of activities, weeding and pest control. AREX works closely with NGOs. Besides AREX working with NGOs on technical training, AREX is not involved in monitoring and evaluation of the project, nor do they keep records on CA yields. Key informant interviews with AREX noted that NGOs keep records and monitor the project. AREX records on yields also revealed that they do not record CA yields separately, yields records combine CA and conventional agriculture system yields. This study established that were also no records on NGOs which were running CA over the years in different wards. Considering that NGOs working on CA in Chivi roll out their projects whenever their funding is finished and a different NGO can take over, at least a government body should be monitoring these activities for uniformity and standard control. CA's use of AREX officials was also blamed for cosmetic participatory learning extension service in Chivi (Nhodo *et al.* 2010 ; Gukurume *et al.* 2010 and Pedzisa *et al.* 2015).

4.4.5 Community role in CA project

Chivi community members are the beneficiaries of the project. All the data sources, except CA farmers' questionnaires confirmed this role, refer to Table 4.3.

Table 4.3: Role of CA farmers in the project

Role	Frequency	Percent
none	3	3.9
participate in decision making	52	68.4
other	20	27.6
Total	**75**	**100**

These NGOs also defined the community as beneficiaries but having an active role in the project which include decision making, practicing CA and marketing their produce. NGOs such as CARE however source markets for farmers. Shortage of markets was also listed by farmers as one challenge under CA. Focus group discussants argued that small grains unlike maize do not have a ready market. They also alluded to decision making which is done at management level and at ward level only includes farm group leaders and traditional leaders. This is in support of (Pedzisa *et al.* 2015; Nhodo *et al.* 2010 and Gukurume, 2013)'s findings. The CA project has been accused of taking a polished top down approach. According to NGOs, the project follows a participatory learning approach whereby at ward level, farmers are led by two group leaders and work in groups of 15 to 30 work on one demonstration plot of 0.2 hectares, sharing ideas and labour. However participatory learning methods where learners remain passive resembles a top down approach. Gukurume (2013)'s study in Chivi noted a contestation of knowledge ideals and conflicting worldviews. These issues arise when locals feel they are not part of the project which is supposed to benefit them.

CA is run by various NGOs in Chivi bound by the standards set by the Zimbabwe Conservation Agriculture Taskforce under Ministry of Lands and Agriculture. Even though there is a document drafted to standardize the operational activities of CA project, there is no uniformity in operations, some NGOs such as CARE are implementing an exit strategy in 12 wards, and ensuring farmers are self-reliant, while others such as Christian care are starting operations in the area with its own framework. In ward 10 Heifer wound up its operations in some villages within the same ward, CA project is still running under SADAP. After rolling out of an NGO another NGO comes in and does not build on what has been implemented by their predecessors but start a fresh project. Focus group discussions revealed that at least three NGOs have operated CA in each ward. This does not only bring confusion but makes it difficult for farmers to see the benefits of CA. The role of stakeholders such as government and farmers is not clear in the CA institutional framework. Farmers need to be involved in decision making processes from the project's inception to its roll-lout. Government of Zimbabwe is represented by AREX in CA, however AREX seem to have limited its operations to providing technical extension services.

4.5 Summary

The nature of CA in Chivi was characterised using the AREX, CARE and Christian care records. Data was elicited through key informant interviews and logical framework reviews. Data was analysed using Atlas.ti 8. Findings were then presented and discussed in light of national policies, FAO standards and theories sustainability and change. Key issues such as the extent to which the project design and implementation is in line with national policies and standards, the project' s alignment to standard theories of operation and environmental consideration and social domains of change such as gender integration. Though CA project has a vibrant framework, some flaws were noted in its principles, institutional and technical framework, which affect its effectiveness as a drought adaptation tool. This chapter gives precedence to the next chapter, which is on evaluating the adoption of conservation agriculture project in Chivi.

CHAPTER 5: EVALUATING THE ADOPTION OF CONSERVATION AGRICULTURE PROJECT IN CHIVI

5.0 Introduction

The effectiveness of a new technology depends on its adoption and also the project's adoption levels reflect on its strength thus convenience and usefulness in the user's interpersonal networks (Giesing, 2003). Adoption is defined "as the extent to which farmers put into practice a new innovation, given adequate information about the technology and the potential benefits" (Ntshangase *et al.* 2017). Antle and Valdivia in their Tradeoffs model inform that farmers are rational beings and only adopt a new system of agriculture if it's more viable. This chapter sought to evaluate the adoption of CA in Chivi.

5.1 Results and discussion

5.1.1 CA adoption in Chivi

The physical adoption of the CA project was measured through data obtained from NGOs operating in Chivi, supported by data obtained from the Focus Group Discussions. The CA adoption figures are based on CA adoption figures records of NGOs operating in Chivi district. Only 30% of households in Chivi are practicing CA (Figure 5.1).

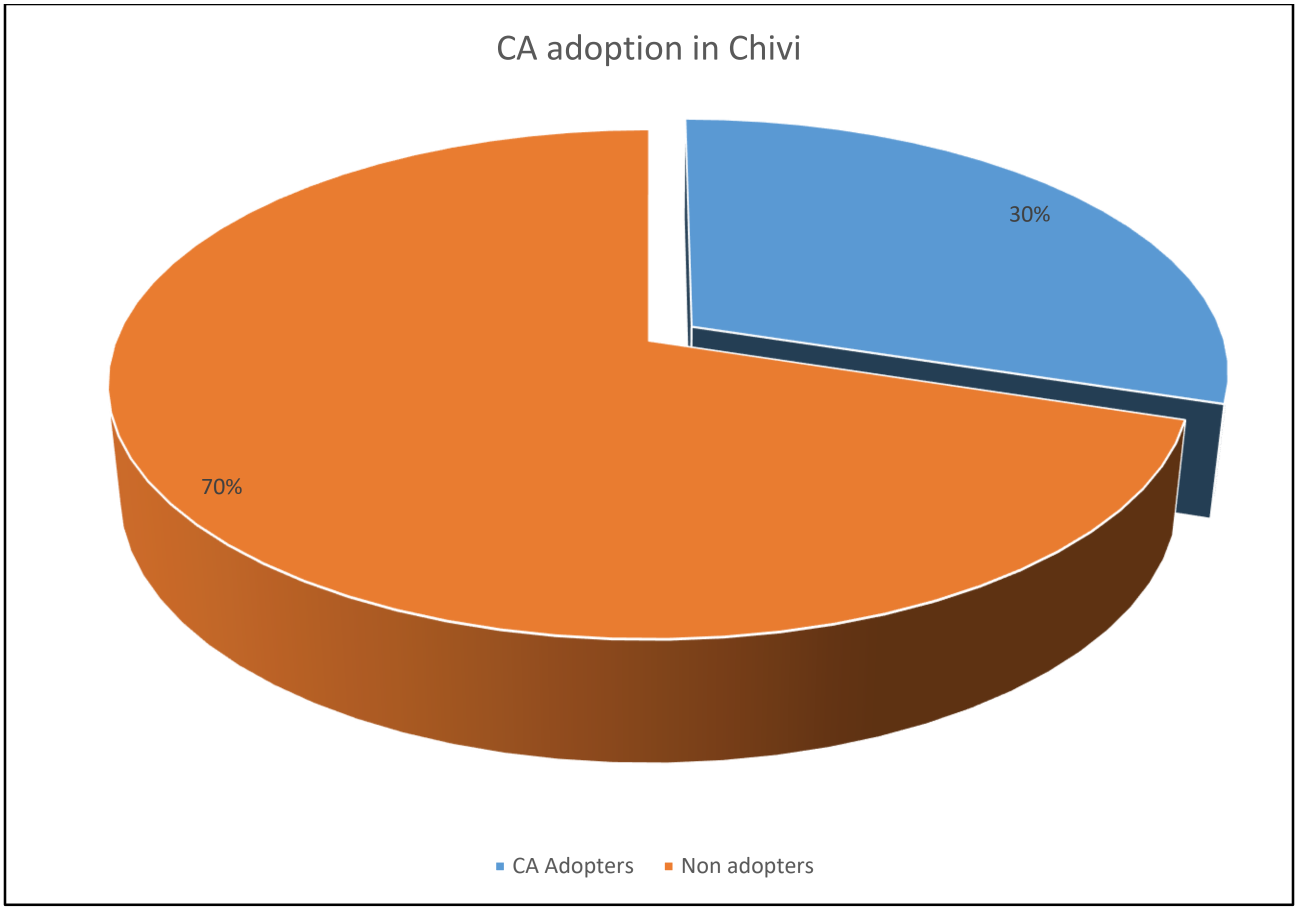

Figure 5. 1: CA Adoption in Chivi

Data from AREX officials and Focus Group Discussions showed that CA started as early as 1995 in some wards such as Ward 10 but became more popular from 2008 when the government of Zimbabwe formalized it and started supporting it. However, CARE International the main NGO, operating in 12 Wards of the District began its operations in Chivi in 2008. This implies that the project is over a decade old. CA benefits start to be realised at least after 10 years (Kassam *et al.* 2014). Hence a thirty percent adoption level is not that bad, considering that the project is slightly over a decade in most wards. After seeing the benefits more farmers are likely to adopt CA. However data on CA adoption trends did not support this. AREX and CARE confirmed a decline in adoption trend over the years in all wards. In ward 21 of the 300 farmers who initially adopted CA in 2008 only 80 are currently practicing it. Of interest is that Ward 21 was listed as the third highest adopter of CA in the district by NGOs. This gives a gloomy picture to the sustainability of CA in the district.

5.1.2 Extension of CA plots

To get an insight into the extent of physical adoption, capacity building and the long term plans of farmers on CA, increase in acreage of CA plots ever since the project was adopted was also assessed. Data from key informants showed that farmers under CARE increased their demo plots from the 18 mother demo plots of 1 hectare to 180 baby demo plots across its 12 wards. In the rest of the wards trend could not be determined due to changing of NGOs operating in these areas. The questionnaire survey showed that 100% of CA farmers are still working on demonstration plots in groups and have not adopted the full practice on their individual plots. However 100 % admitted to have adopted at least one of the CA principles and are using them in their conventional agriculture system. 52% of these farmers adopted planting on time, 80% crop rotation and 38% use of small grains. No CA farmers are using planting basins and mulching in their conventional systems. NGOs confirmed these findings and added that planting basins and mulching principles are the most unpopular. These two principles could be the barriers to adoption of CA in Chivi.

5.1.3 Community social buy in into CA

Community buy in of the CA project was assessed to get the level of social acceptance of the project. Social narratives and verbatim around the CA project was used as indicators. 72% of participating groups under Focus group discussions described their role in CA as beneficiaries, refer to Figure 5. 2 below and very few had an active verbatim concerning their role under CA.

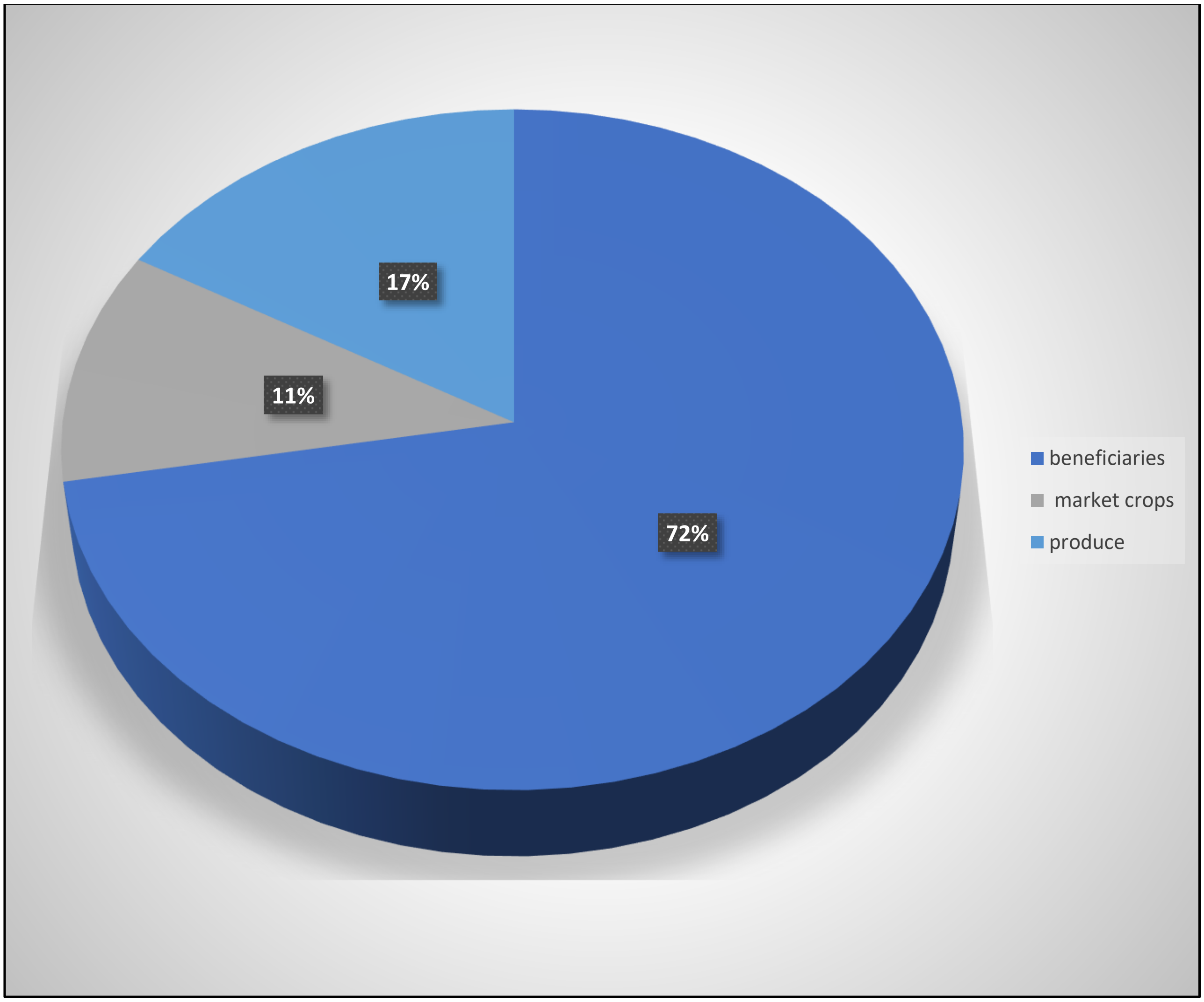

Figure 5.2 Role of Chivi community in CA

Verbatim assessment by Wards showed that only 28% of participant Wards had a positive view about the role in CA. Ward 21 and 24 showed an active role in CA (Figure 5.3). Ward 10 besides it being the first ward to be introduced to CA in 1995, over two decades ago it showed a passive role in CA project.

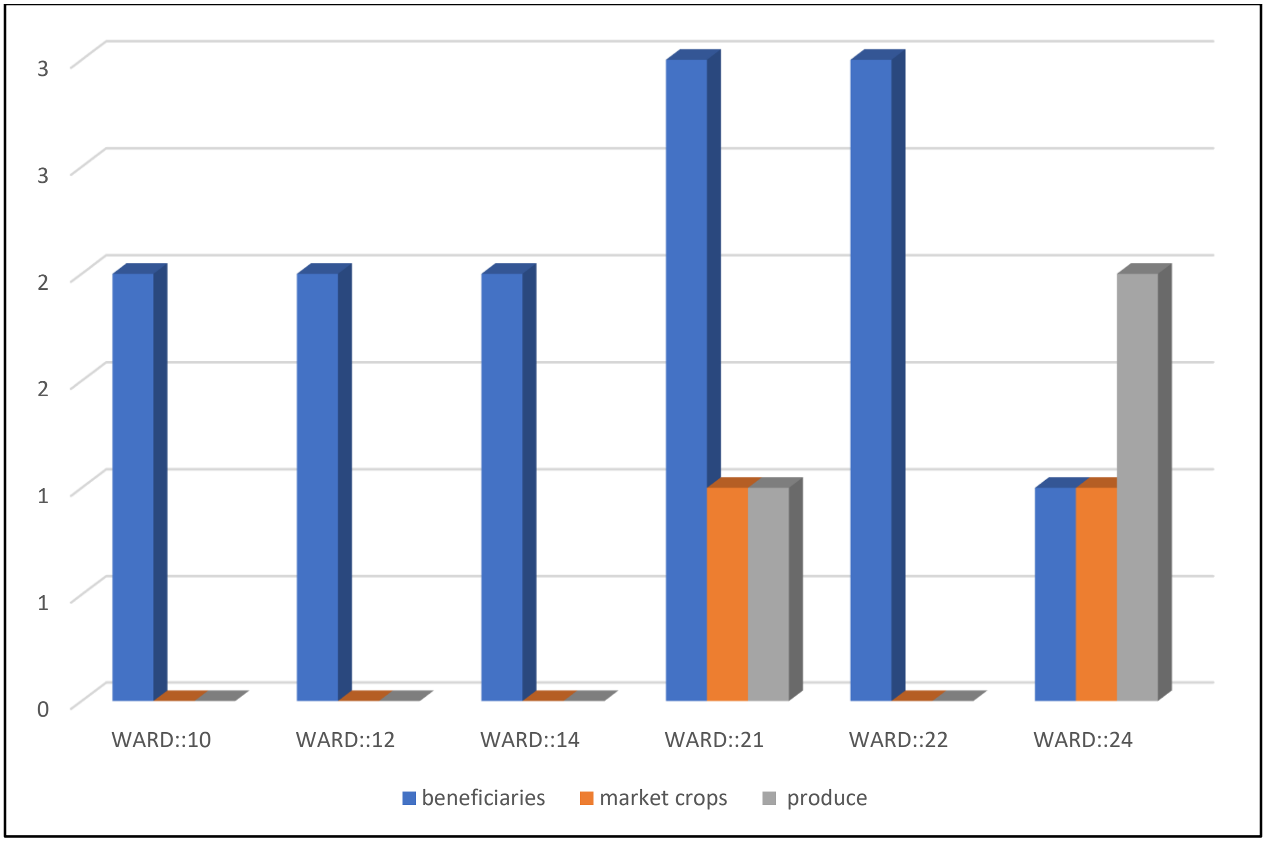

Figure 5.3 Role of Chivi community in CA by Wards

Focus Group discussion participants of about 72% regarded themselves as beneficiaries of CA and had no active or decisive role in the project. The community described NGOs as the "owners" of the project while AREX officials were described as "trainers". Throughout the whole cycle from its formulation to implementation community members are passive participants. On discussion surrounding difference between CA and the conventional farming, 77% of participants showed that there is no difference in terms of benefits, this contradicted the views of NGOs and AREX officials, whom most of them pointed out the difference in yields per hectare in which CA has better yields.

Community buy-in findings showed that 80% of AREX officials described Chivi CA project buy in as low and slow. "Reluctant" and "not eager" were the most commonly used words to describe community buy in. Drought was also mentioned as a barrier to community buy-in. The benefits of CA are said to be less visible due to recurrent droughts. Chivi community through Focus group discussions also confirmed low buy into the CA project but had different reasons, refer to Figure 5.4.

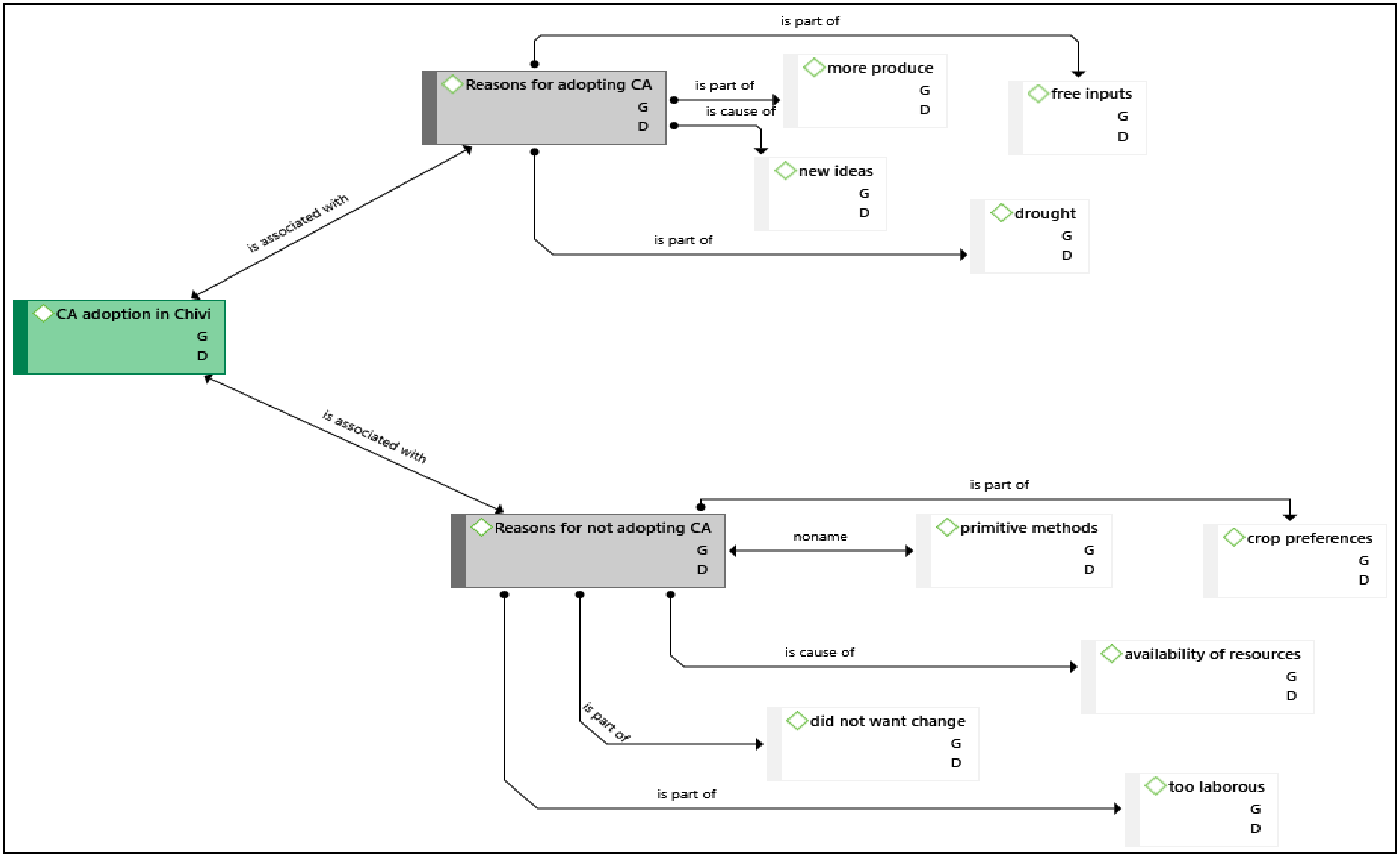

Figure 5.4 CA adoption in Chivi District

The participants who adopted CA, did it for various reasons, 34% adopted for new farming ideas, 17% for free inputs, 17% to increase production and 32% to adapt to drought effects. The participants who did not adopt CA had also their own reasons, 34% mentioned use of primitive farming and labour intensive methods, 34 %did not see the need as they have enough resources to continue with conventional farming and 32% did not prefer small grains and changing their traditional farming system. All, 100% of participants were aware of the challenges faced in agricultural production however they did not see CA as the solution to their challenges. The interesting argument was that CA is affected by drought the same way as conventional agriculture system. This was also indirectly brought up by AREX and NGOs interviews. They attributed the negative attitude of farmers towards CA to lack of tangible benefits which are being washed away by recurrent drought in Chivi.

5.2 Factors affecting CA adoption in Chivi District

Besides the direct barriers to CA adoption mentioned by the Chivi community members, several variables were used in this study to get an insight into other domains affecting CA adoption. Variables such as human capital, socio-economic and physical assets were assessed through a questionnaire administered to household heads. This provided an insight not to factors affecting the current performance of the project but also into ascertaining the sustainability of CA in Chivi.

5.2.1 Human capital and CA adoption in Chivi

Demographic characteristics of the participants, which are the household heads were used to assess human capital and CA adoption in the District.

5.2.1.1 Gender

Gender is an important characteristic in the adoption of CA considering the associated gender roles and dynamics especially in rural communities.

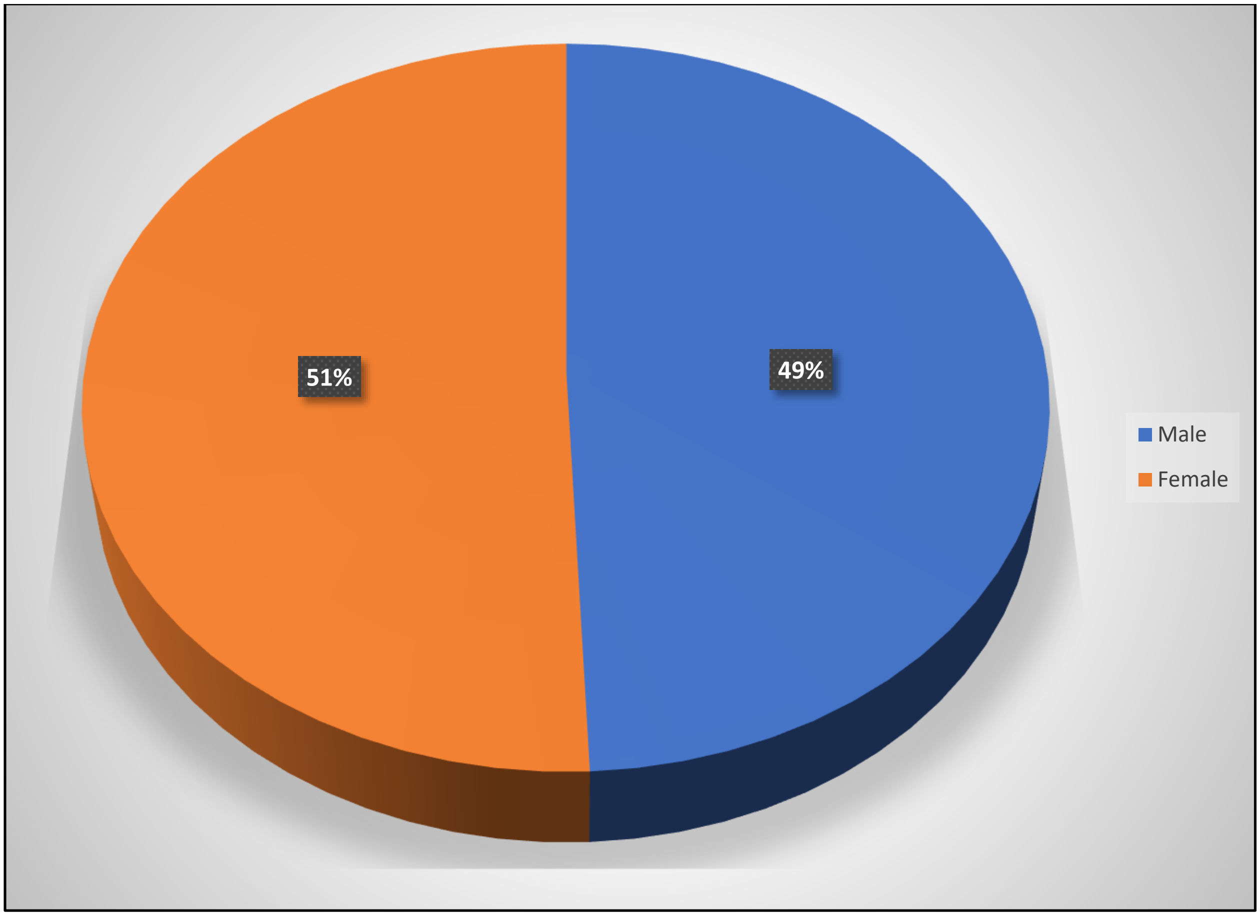

Figure 5.5 Distribution of participants by gender

Slightly more females participated in the household survey (Figure 5.5). About 51% female and 49% male household heads participated in the study. Chivi has a generally higher number of females directly involved in small holder agriculture (ZimStat, 2012). However to establish the gender dimensions in CA a balance had also to be made between the gender of participants, hence a slight difference of 50.7 to 49.3% ratio.

Cross tabulation of gender and CA adoption, revealed that most women adopted CA with a 64% against a 43% of male CA farmers (Figure 5.6).

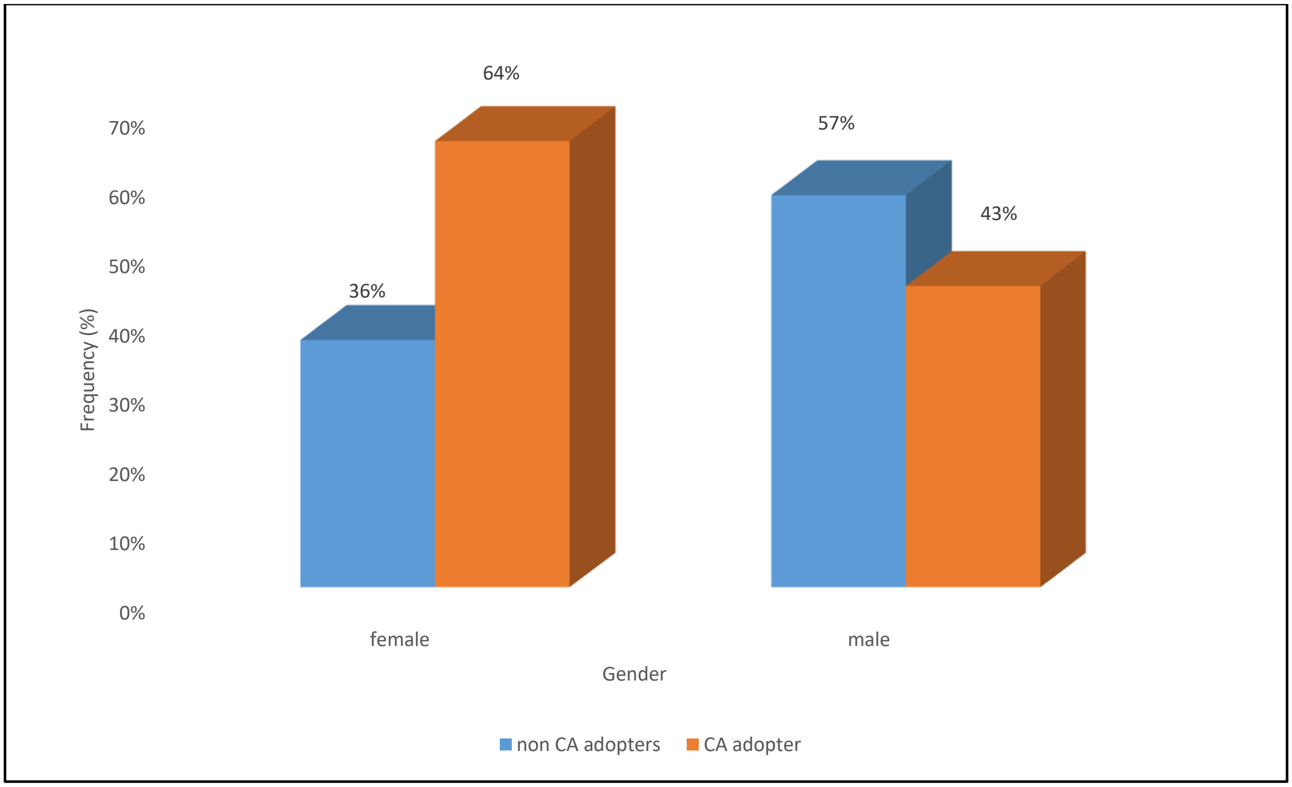

Figure 5.6: Cross tabulation of participation in the Conservation Agriculture by gender

Chi-square (χ2) test was used to associate gender with CA adoption. The findings showed a relationship between gender and CA adoption.

Table 5.1: Gender and Conservation Agriculture adoption

Variable	Chi-square	df*	p-value	Cramer's V
Gender	6.056a	1	.014*	.209⁰

*= P < 0.05, **= P < 0.01, ***= P < 0.001; ⁰= no relationship to weak; ¹= moderate relationship; ²= strong relationship

The Chi-square (χ2) analysis revealed a significant association of gender with being a conservation farmer (*p*<0.05). However a Crammer test classified the relationship weak. The results are supported by other surveys done in Chivi, which showed that women constitute the majority of communal small holder farmers (ZimSat, 2012 and Mudzonga, 2012). This was also confirmed by the interview held with Heifer and CARE international. NGOs are targeting women in their CA projects, hence more women have adopted the project. However with more women involved in CA, the project design ought to have special design characteristics in its functions such as flexibility to suit women's gender roles and their often tight work schedules for sustainability. The CA activity plan used in Chivi contradicts this. According to ZCATF (2009) CA project activities run throughout the year. It is also important to note that, CA project run concurrently with the conventional agriculture, the main agriculture system practiced by every farmer as well as livestock farming. Therefore time management could be affecting CA adoption and would certainly hinder its effectiveness as a drought adaptation tool.

5.2.1.2 Age and CA adoption

Adoption of a new agriculture technology does not only depend on the nature of the technology but also its intended users. The heterogeneity of farmers and their farm systems influence the adoption of a new innovation (National Research Council, 2002). Age is influential in new technology adoption. According to Sunding and Zilberman (2001) adoption of new technology declines with age. The findings on age showed that more participants were the active age group, the 30 to 50 year age group, followed by 51 to 60 year group, then the 60 plus (Figure 5.7).

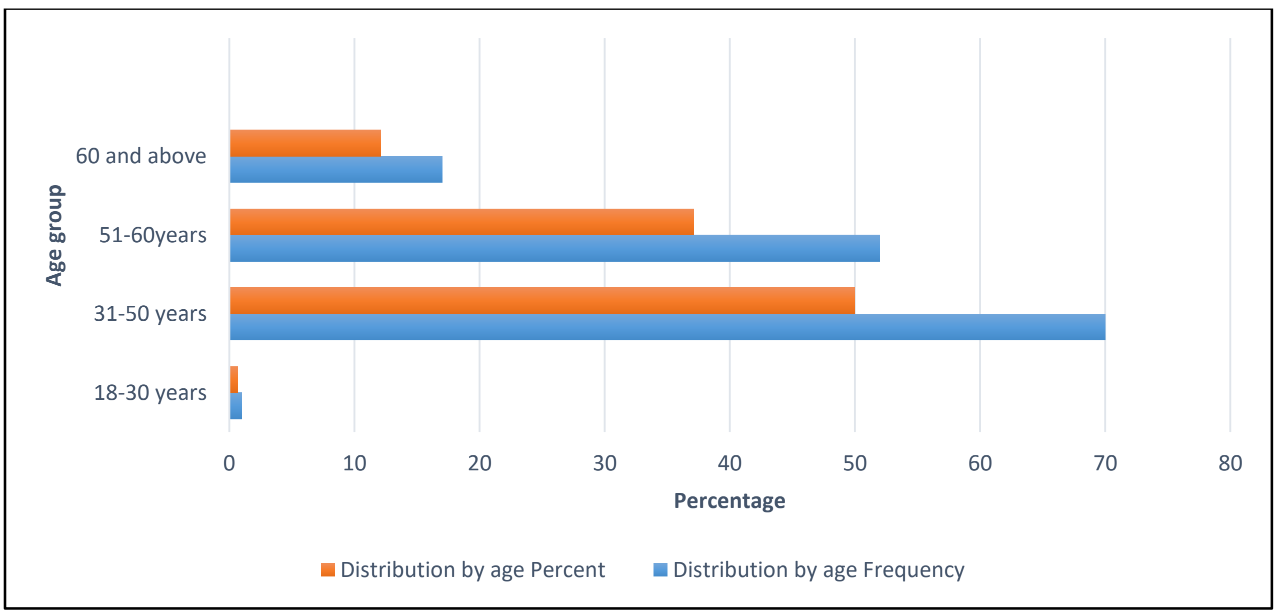

Figure 5.7 Distribution by age

The 18 to 30 age group had the least participants. The relationship between age and CA adoption was insignificant. Chi Square results revealed no association between age (p>0.05) and CA adoption, refer to Table 5.2.

Table 5.2: Age and Conservation Agriculture adoption in Chivi

Variable	Chi-square	df*	p-value	Cramer's V
Age	1.601a	3	.659	$.107^{0}$

*= P < 0.05, **= P < 0.01, ***= P < 0.001; ^{0}= no relationship to weak; ^{1}= moderate relationship; ^{2}= strong relationship

Despite these findings, it is also important to note that the Chivi age structure revealed a community operating in a poor economic environment, considering that the active population is fully engaged in small holder farming as opposed to the norm that active population is found working off the family compounds in towns and cities. It also showed that small holder farming is a source of livelihood in this community, hence there is need for sound agricultural innovations to boost livelihoods. On the positive side, the Chivi age structure consisting of a higher percentage of the active population is not affected by new technologies and is good for effective information dissemination critical in CA adoption (FAO, 2019). Younger farmers make long-term plans in their operations and acquire necessary skills and knowledge unlike old farmers (National Research Council, 2002). However age is not the only influencer of information dissemination, level of education is also of paramount importance for comprehension of information and querying of information sources.

5.2.1.3 Level of education

Adoption of a new technology can be affected by levels of literacy. Level of education among Chivi farmers was also assessed (Figure 5.8).

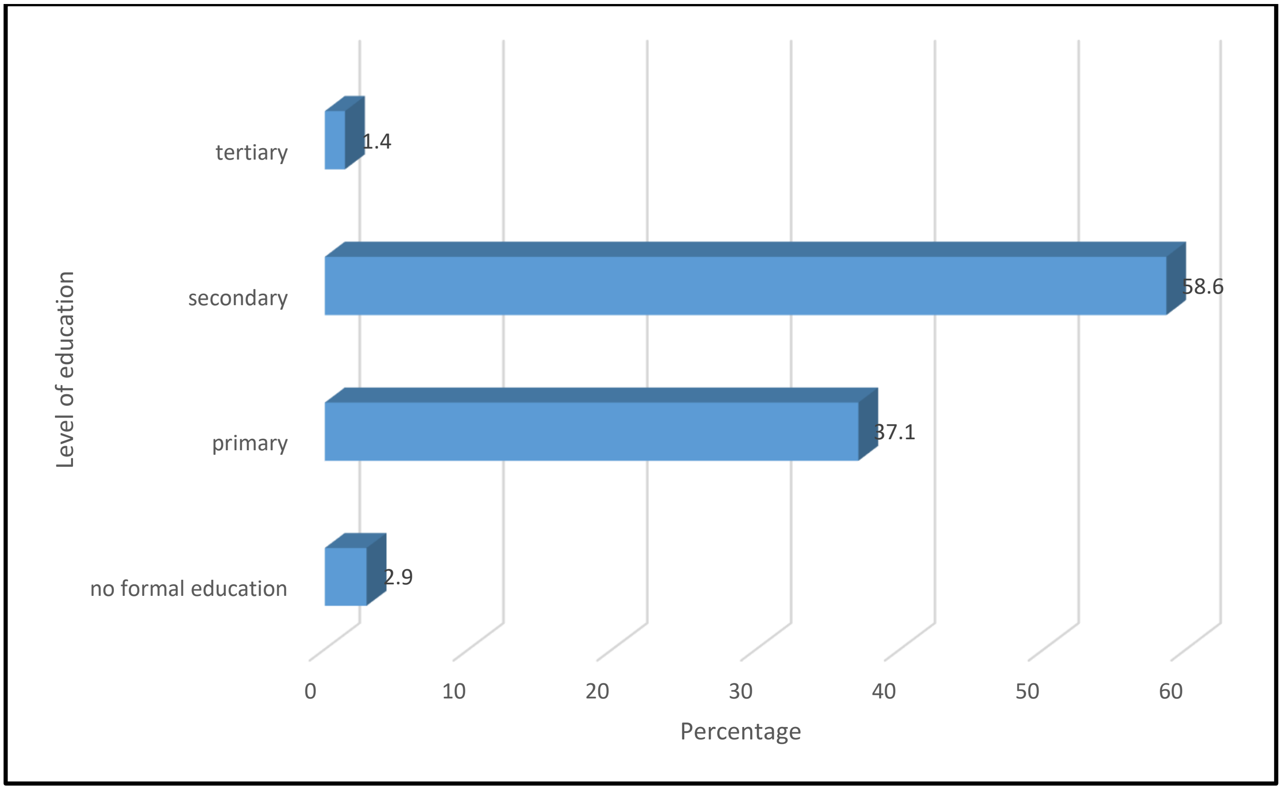

Figure 5.8 Level of education

Majority of participants had secondary education with a 58.6%. Participants with primary education were 37.1%. The least participants had a tertiary qualification about 1.4% followed by those who never attained any formal education with 2.9%. The findings showed a District with a literate population. This means that Chivi community is very much aware of their environment and if given adequate information on CA can comprehend it and make informed decisions on adopting or not adopting. In this case low adoption would have more to do with the applicability or feasibility of the project design and assets rather than human capital. No significant statistical relationship was found between the level of education and CA adoption.

Table 5.3 Level of Education and CA adoption

Variable	Chi-square	df*	p-value	Cramer's V
Level of education	3.493a	3	.322	.159[0]

Therefore CA adoption in Chivi is not influenced by age nor the level of education.

5.2.1.4 Marital status

Social dimensions such as marital status are also of greater value in the adoption of an agricultural technology (Nhodo *et al.* 2010). Marital status and gender are critical in decision making, especially in crucial issues such as adoption of a new farming system. Issues such as gender decision making roles and land ownership come into play. Marital status in Chivi was examined, refer to Figure 5.9.

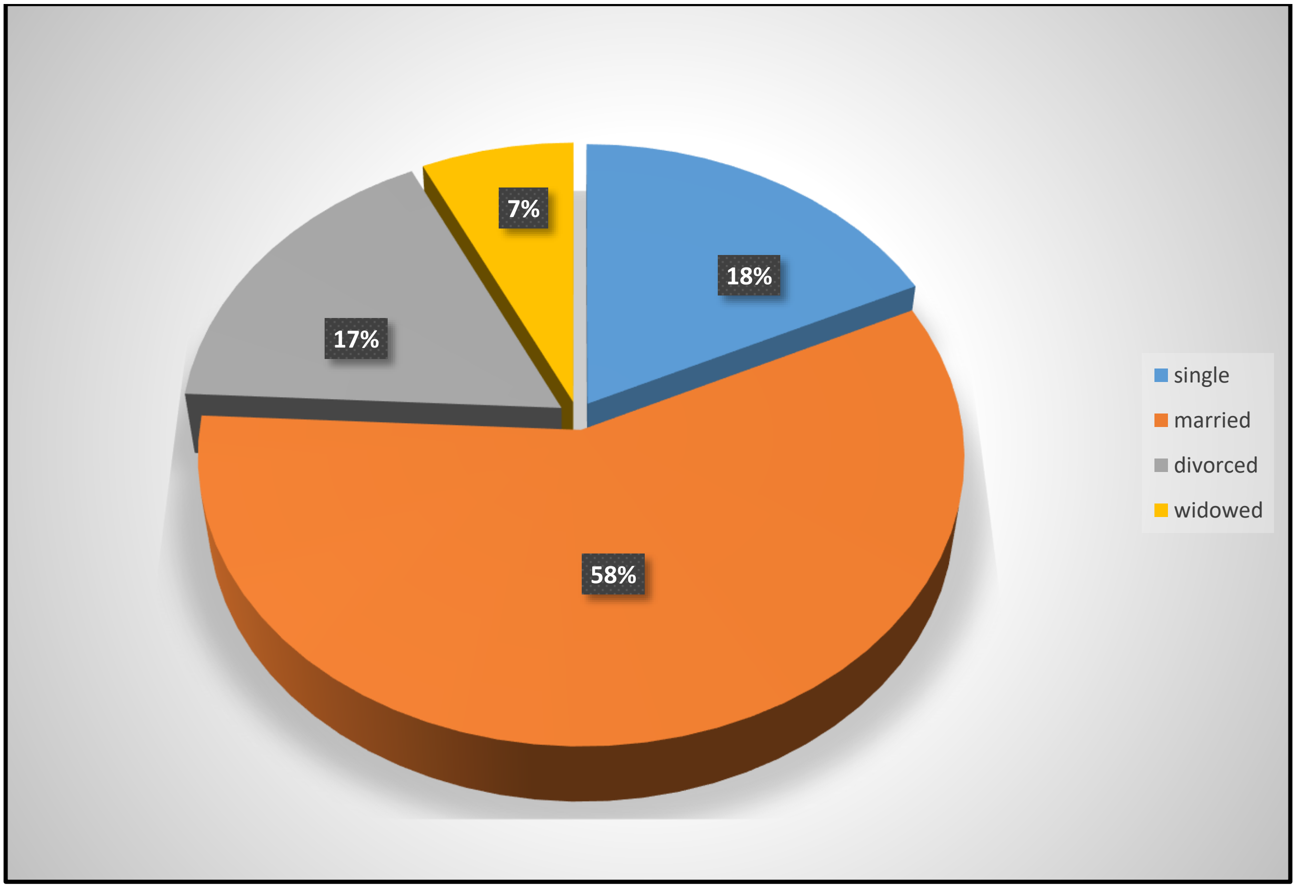

Figure 5.9 Marital status in Chivi

Majority of the household heads who participated in this study were married, with a 58%. Single participants constituted 18% whilst 17 % were divorcees and 7% widows. This married to non-married ratio of 58:43% is a true reflection of the marital status in Chivi. According to ZimSat (2012) census report population of widows and divorcees is rising due to factors such as prevalent HIV/AIDS and economic hardships. In a social structure such as this there is a need for developmental projects such as CA to strengthen weak social networks and support the existing ones and avoid project domains that create or exacerbate social tensions.

The Chi Square test showed no statistically significant relationship between marital status and CA adoption.

Table 5.4 Marital status and CA adoption

Variable	**Chi-square**	**df***	**p-value**	**Cramer's V**
Marital status	.280	2	.869	.0610

Despite a direct link between CA adoption and marital status, inherent gender dynamics in marital status of a rural society such as Chivi needs a closer scrutiny. The strength of gender roles in decision making and land ownership might not be visible on the ground but has a huge indirect influence on adoption of an agricultural innovation such as CA (Nyanga *et al.* 2012). These gender roles are well-defined in Chivi, a predominantly rural district with 30 out of 32 rural wards (ZimSat, 2012 and Chineka, 2019).

An interview with CARE key informants on gender gaps in Chivi also acknowledged existent gender gaps. The organisation had problems with the registering Chivi women to a CA sister project of Nutritional gardens. Most women would register into the project under their husbands' names some of which divorced them and some not even in the community, working either in the cities or outside the country. This shows that even though women are the producers they are not the decision makers nor practical land owners. This becomes a bit complicated when they have to make crucial and life changing decisions such as changing the farming system from conventional plough system to digging permanent planting basins. There is need to mainstream gender into a CA project, lest it might affect the sustainability of CA or further widen the gender gaps that already exists in agriculture.

5.2.1.5 Employment status

Financial capacity as well as off field commitments also influence the adoption of CA technology. Employment status of participants was assessed, refer to Figure 5.10 below.

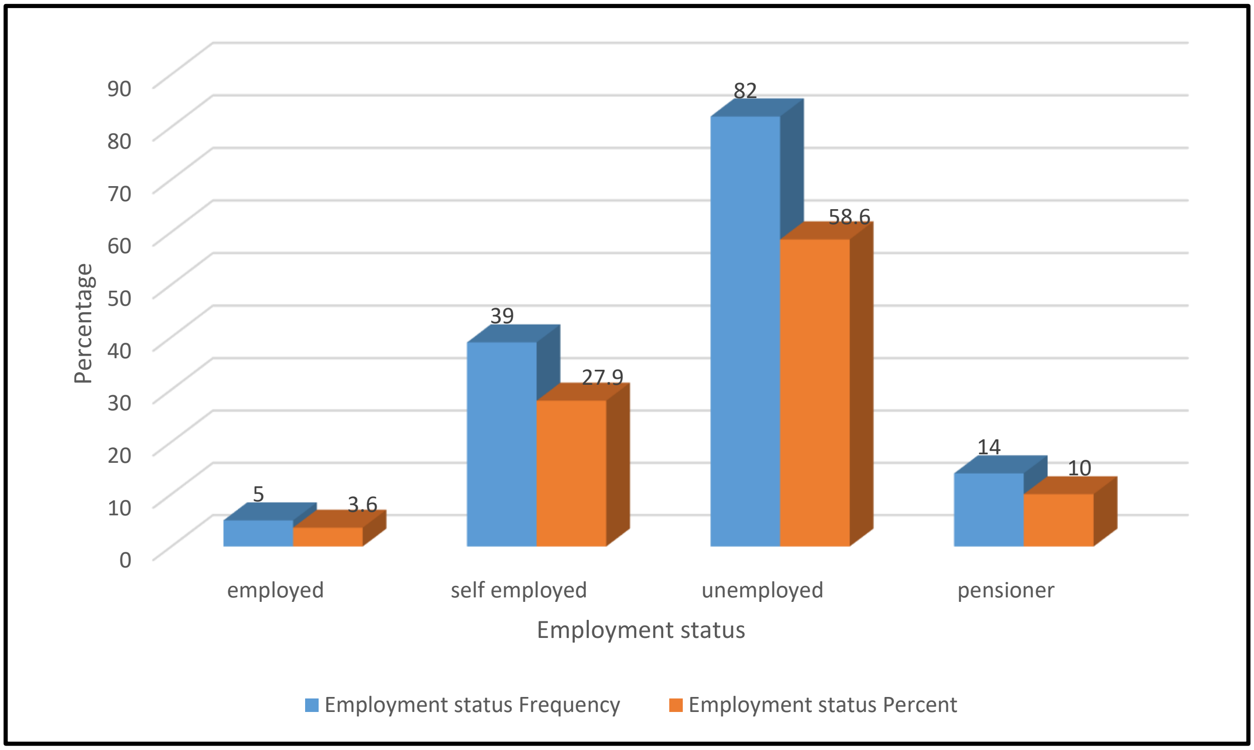

Figure 5.10 Employment status

Most household heads who participated in this study were unemployed. About 59% of the participants were unemployed. Very few participants were employed with a 3.6% and about 28% who were self-employed whilst 10% were pensioners. However no statistically significant relationship was found between employment status and CA adoption in Chivi District (Table 5.5).

Table: 5.5 Employment status and CA adoption in Chivi

Variable	Chi-square	df*	p-value	Cramer's V
Employment status	2.249a	3	.522	$.127^0$

Generally the rate of employment in Chivi is very low and people who are employed work outside the district (Mudzonga, 2012 and Nhodo *et al.* 2010).

5.2.1.6 Incomes

Participants' monthly incomes were analysed. These incomes were put into two categories using the UN's poverty datum line of US$1.90 per individual per day, calculated by 30 days of the month. This was further multiplied by 4 which is the average household size for Chivi District (ZimStat, 2012). Refer to Table 5.6 below.

Table 5.6: Chivi monthly household incomes

Amount	Frequency	Percent
≤$227	97	69.3
≥$228	43	30.7
Total	140	100

Most participants, which constituted 69.3% had a monthly income below the poverty datum line while only 30.7% of the household were out of this threshold. This supports the UN (2019)'s assertion that sub-Saharan Africa has most of the people living below the poverty line together with South Asia. Focus group discussions raised an interesting argument on CA impact on Chivi community. Participants who adopted CA at its inception mentioned free inputs as one major reason which made them buy into the project while the non-adopters argued that CA blocked the issuing of free drought relief food by NGOs. These arguments speak to the high levels of poverty in the community. Hence for CA technology to be acceptable in the community it has to prove itself as a viable income generating project. 82.7% of the farmers practicing CA yield an average of 15 bags yields per shared plot. This is not lucrative enough to motivate farmers, CA farmers also mentioned cost of inputs as their greatest challenge (Table 5.7).

Table 5.7: Cost of inputs challenges

CA challenges	Frequency	Percent
cost of fertilizers	58	77.33%
Cost of machinery/ripper tines	17	22.67
Total	75	100.00%

The high cost of inputs demotivates farmers. CARE and AGRITEX also confirmed costs of inputs as a challenge. According to CARE, the first phase of their operation SPIR1 free inputs were being given to farmers to introduce them to the project but their second phase SPIR 2 seeks to cut donor depends on farmers, hence inputs are sold under agro-dealers. While cutting out donor dependence was good for the growth and sustainability of the project, the economic status of Chivi community is very unstable, hence would require a project design which does not further constrain their pockets.

5.2.2 Socio-economic assets

Socio-economic variables such as household size, farm labour availability, family support, social networks and financial assets were assessed. Chi-square (χ2) analyses revealed no significant association between households' socio-economic capital factors and being a conservation project farmer (p>0.05) in all the aspects except one (Table 5.8).

Table 5.8 Socioeconomic capital factors associated with being a CA farmer

Socio-economic indicators	Chi-square	df*	p-value	Cramer's V
size of your household	1.003ᵃ	2	.606	$.085^{0}$
enough farm labour	.001ᵃ	1	.971	$.003^{0}$
family members employed off family compound	.029ᵃ	1	.865	$.014^{0}$
support during drought	4.727ᵃ	3	.193	$.184^{0}$
member of any social scheme	2.324ᵃ	1	.127	$.129^{0}$
non-agricultural income generating projects	9.549ᵃ	4	.049*	$.262^{0}$
financial assets	3.262ᵃ	2	.196	$.153^{0}$

*= P < 0.05, **= P < 0.01, ***= P < 0.001; ^{0}= no relationship to weak; ^{1}= moderate relationship; ^{2}= strong relationship

A significant proportion of household heads who sell carvings (80%) are not conservation project farmers, whereas 76% of household heads who sell firewood are conservation project farmers (Figure 5.11).

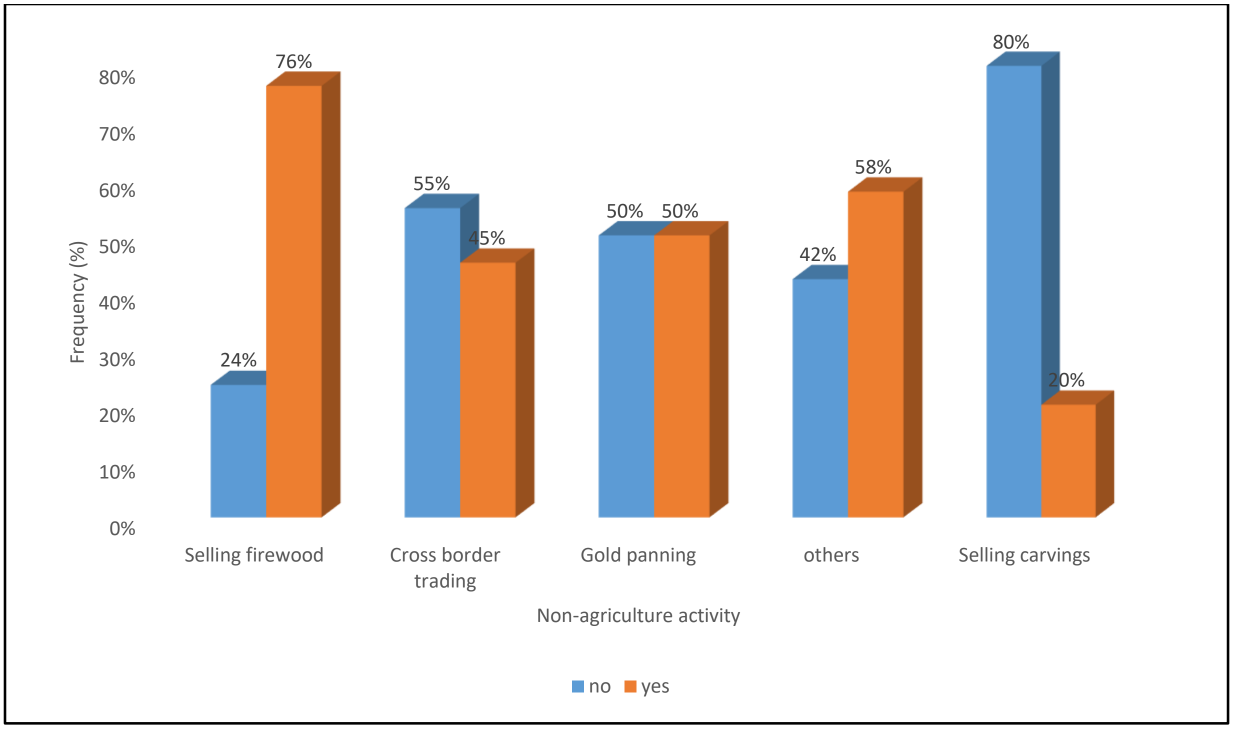

Figure 5.11: Non agricultural income generating projects and CA adoption in Chivi

This speaks to the lucrativeness of these projects. According to Antle and Valdivia (2011) farmers opt to adopt a more lucrative system. Selling carvings especially in Chivi along the Beitbridge-Harare road and cross border trade might be more lucrative than CA and the opposite might be true for selling firewood. Despite the fact that some of these activities are not environmentally sustainable, farmers in Chivi are in need of a system that would boost their incomes. Despite social networks having no significant relationship to CA adoption. Social networks are very weak in Chivi. 82% of household sizes are four plus and about 62% of family members work off family compounds, however there is insignificant remittances in the community. During droughts most support comes from the government and NGOs, while family members' support averages to 28.6%. While 55% of the household heads who participated in the questionnaire were not associated with any social scheme.

5.2.3 Physical assets

The physical assets of a household are crucial in the resilience of the household to drought risks. Physical assets such as water resources, soil quality, transport, source of energy, services, land sizes and livestock herds were assessed. The findings showed that 51.4% travel between two to four kilometers while 24.3% go for over five kilometers to fetch water for domestic purposes and all respondents depend on rain for agriculture. Chivi being located in agro-ecological region five receives an average of less than 500mm (ZimSat, 2012). This shows that water is a challenge in Chivi community. Soil quality is also a challenge, 87.9% of the respondents classified their soils as poor. This was also supported by AGRITEX and NGOs officials working in Chivi.

Services are inaccessible in Chivi. Findings of the survey indicated that resources such as banks, agricultural markets and agricultural extension services are located far from the farmers with farmers walking an average of 44kms, 22.8kms and 7.7kms to access banks, agricultural markets and agriculture extension services respectively. These distances adds on the burden farmers already have in their villages but most importantly it deters farmers from accessing services such as loans and markets which are crucial in their operations and subsequently affect the effectiveness of CA as a drought adaptation strategy.

All respondents had land and livestock but lacked boreholes, scotch carts, cars and electricity. On livestock findings showed that the farmers have large herds of donkeys, with 48.6% of the respondents having more that eleven donkeys. Other popularly owned livestock include cattle, with 15.7% of the farmers having at least eleven cows and poultry, with 22.1% of the farmers having at least eleven birds. Generally the community has a high number of livestock. Chivi practices mixed farming. Livestock is not only a symbol of wealth but a source of draught power for plough farming and running household chores such as fetching water and firewood.

Cattle is the most valued livestock, cattle is occasionally sold for household income needs and a great drought cushion asset (Chineka, 2016). Of interest is also the ownership of livestock, women own poultry mostly while cattle belongs to patriarch. Livestock being of such great value especially during drought periods, CA principles such as mulching and planting basins do not only contradicts the existent agricultural systems in Chivi but adds strife on gender dynamics of decision making, ownership of resources at both household and community level. These findings concedes with Nhodo *et al.* (2010) and Gukurume

(2013). These studies noted a social tension in Chivi between CA adopters and non-adopters. This study noted even a tension amongst adopters, most adopters joined the project during the free input phase, and they did not have an active voice of their roles in the CA project. They seem to struggle with integrating CA into their normal practices, the main challenges being contradictory principles, land ownership, decision making roles and lack of visible benefits. As a drought adaptation strategy, both farmers and the project officials confirmed that CA benefits are eroded away by drought.

5.3: Summary

This chapter has evaluated the adoption of CA in Chivi. CA adoption figures, extension of CA plots, community social buy-in the project as well as factors influencing CA adoption have been presented and discussed. First-hand information sourced from Chivi community through questionnaires, key interviews and focus group discussions was used. In order to determine the relationship between different variables and CA adoption, the variables were further tested using a spearman rank correlation co-efficient and chi square test to ascertain the existing significant relationships between the variables.

CHAPTER 6: COMPARISON OF FOOD CROP PRODUCTION PER HECTARE UNDER CONSERVATION AGRICULTURE AND CONVENTIONAL AGRICULTURE

6.0 Introduction

For CA to be considered an effective drought adaptation strategy in Chivi, it has to boost agricultural production. This chapter compares food crop production per hectare under CA and conventional agriculture in the district. The first section presents food crop preferences and trends in food crop production. The second section of this chapter compares food crop production between CA and conventional agriculture. This chapter presents and discuss data elicited from the AREX and CARE records. The data from household questionnaires, key interviews and focus group discussions was used to support the secondary data findings.

6.1 Results and discussion

6.1.1 Food crop production in Chivi District

Climate and food crop preferences affect the crop varieties grown in an area (Mudzonga, 2012). Chivi community grows a wide range of crops, however maize, groundnuts, Bambara nuts, sunflowers, millet and sorghum are some of this community's preferred crops. The community' staple diet being the thick porridge (sadza) made from cereals such as maize, sorghum and millet, these are the main food crops in the district. Despite the maize crop being not suitable for Chivi which falls under agro-ecological region five with a mean rainfall of 450mm, it is widely grown Mudavanhu, 2010 and Chaguta, 2010 (Figure 6.1).

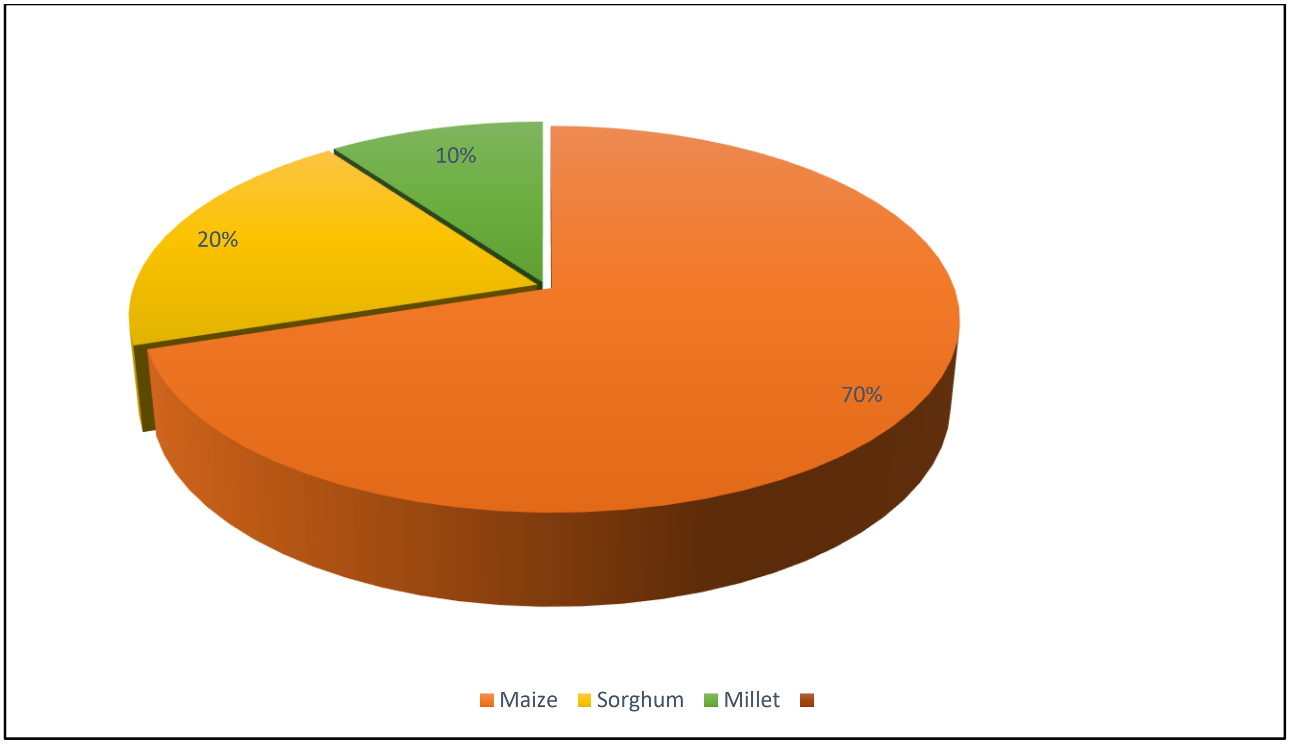

Figure 6.1: Food crop production in Chivi

6.1.2 Trends in food crop production in Chivi District

Food crop production showed a fluctuating trend over the years. The AREX officials attributes the production trend matches to rainfall patterns in Chivi. Previous research in Chivi also support this assertion (Mudzonga, 2010; Chaguta, 2010 and Chineka, 2016). A general fall in food crop yields over the past 30 years in Chivi was noted (Figure 6.2). This supports the ZCATF (2009) and Marongwe *et al.* (2011) report that food crop production in Zimbabwe is generally decreasing. Cereal production in Chivi showed a generally uniform trend.

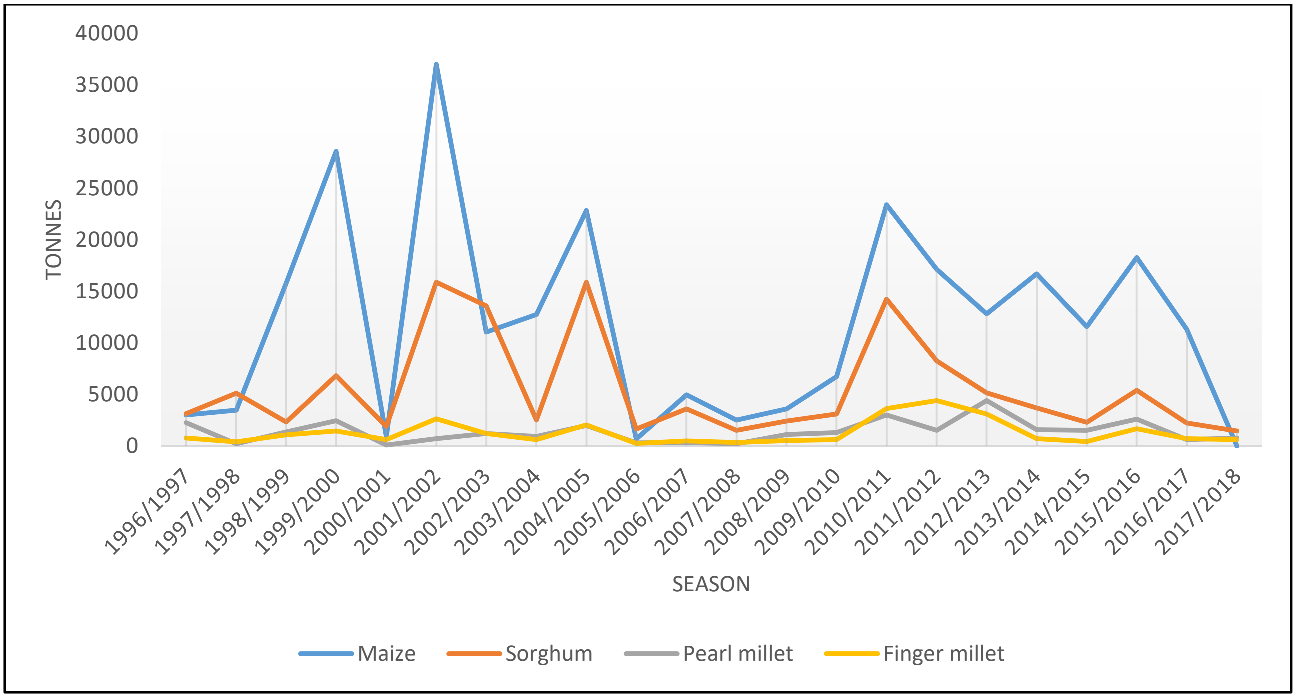

Figure 6.2 Food crop production trend in Chivi

This implies that the cereals react to the changes in rainfall patterns the same. This contradicts the NGOs and AREX's perception that small grains do well in Chivi district than maize.

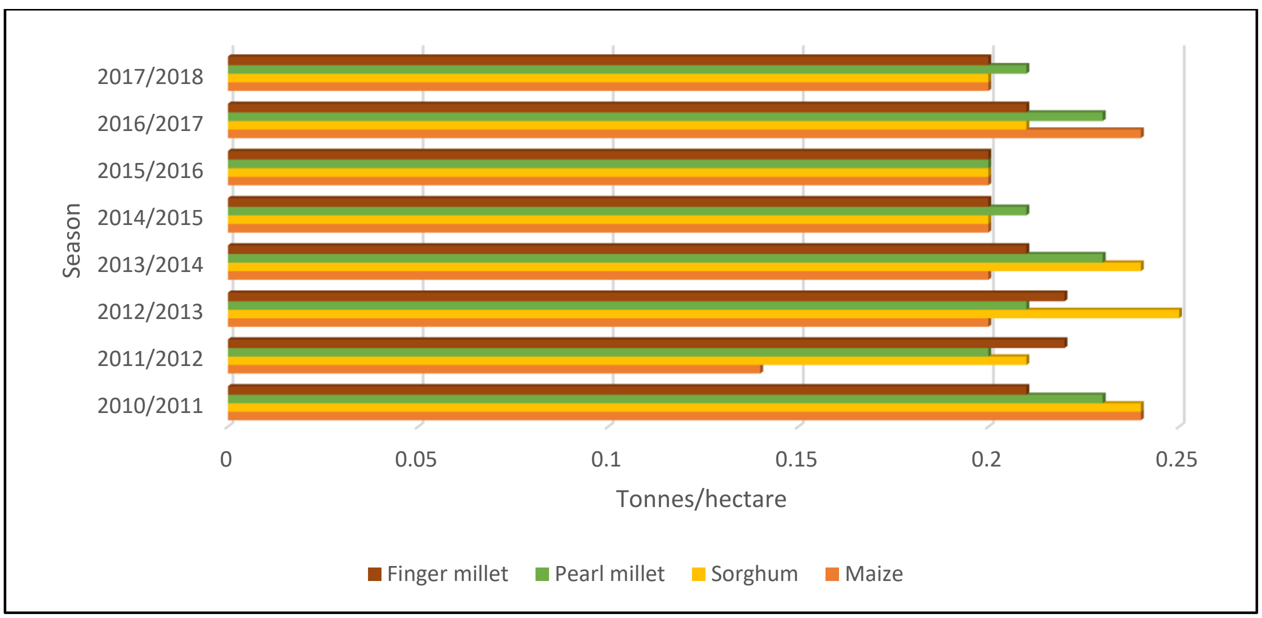

Figure 6.3 Food crop yields per hectare in Chivi

However the yields per hectare findings supported the officials' perceptions (Figure 6.3). Maize yields per hectare are generally lower than small grains, thus sorghum and millet varieties. Hence small grains mostly used in CA are more drought tolerant.

6.1.3: Comparison of yields per hectare under CA and Conventional agriculture

NGOs and AREX records were used to ellicit CA yields trend.Conventional agriculture system had a generally low trend in both crop varieties. Despite CA farming being practiced on small plots, its yields are far higher than those of conventional agriculture, refer to Figure 6.4.

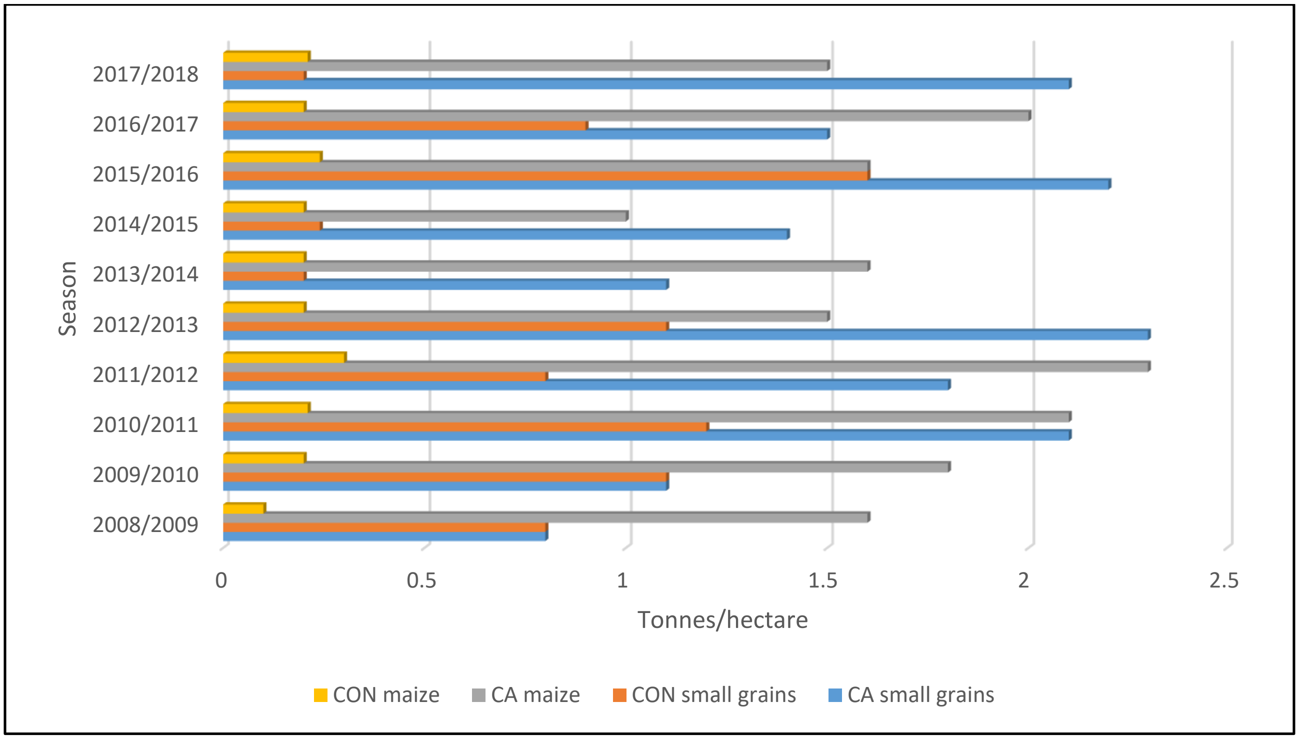

Figure 6.4: Food crop production under CA and Conventional agriculture

Both maize and small grains under conventional agriculture had lower and almost similar yields. Small grains under CA system had the highest yields. This supports the view by NGOs and AREX officers that CA system produces better yields especially with small grains. Zishiri (2013) and Makuvaro (2014) also noted small grains' resilience to dry climate. Despite the small grains performing better under dry conditions, small grains are grown on small pieces of land. CA project is also done on demo plots of 0.1 to 0.2

hectares. Mango (2017) supports this view, and informs that CA plots remain small dots surrounded by vast land of conventional agriculture.

6.1.4: Comparison of CA and Conventional maize production at farm level

Food production at household level was assessed using the household questionnaires. Farmers using both farming systems had their maize yields assessed. Findings revealed that 37.3 % of farmers yielded more than 20 bags per hectare under CA as compared to only 17.3 % under conventional system. This implies that maize under CA has higher yields than conventional agriculture. This contradicts popular belief that maize crop is not suitable for Chivi (Twomlow *et al.* 2006; Makuvaro, 2014; Marongwe et al. 2013; Mudavanhu *et al.* 2013 and Chaguta 2010). Rusinamhodzi *et al.* (2011) also reported a higher yield under CA in the well-drained soils of Zimbabwe which include Chivi. Thierfelder and Wall (2012) conceded and noted higher yields of maize under CA on sandy soils in dry climate than in wet areas. These are the similar environmental characteristics of Chivi. Nyamangara *et al.* (2014)'s study across Zimbabwe supported all these findings and notes that CA maize does well under basin system in dry regions where soils are well drained. Even though agricultural production showed to be better under CA, the area under CA is still too small. Farmers still work on plots which they have to share returns amongst 15 to 30 members per plot. Hence the benefits of CA at a household level look insignificant.

6.2 Summary

This chapter presented and discussed findings on food crop production under CA and conventional systems. Secondary data was used to compare yields at a district level while primary data from questionnaires enabled food crop production at a household level. General food crop production in Chivi is declining. Not much difference in trends of all cereals was noted under conventional agriculture. This implies that both maize and small grains are affected the same way by environmental factors in Chivi. CA has higher agricultural productivity than conventional agriculture. However CA is being practiced on small plots and the community work on CA plots in groups, hence they share profits and very little returns reach the households.

CHAPTER 7: SOCIO-ECONOMIC IMPACTS ASSOCIATED WITH CONSERVATION AGRICULTURE IN CHIVI

7.0 Introduction

Socio economic impact assessment refers to quantitative or qualitative evaluation of the utility of the project based on set indicators (Nkala, 2012 and Pedzisa, 2016). This chapter sought to assess socio-economic impact associated with CA in Chivi. The chapter covered on at the background of agriculture in Chivi, associated challenges as well as the link between CA and the desired change in Chivi. This is then followed by the results presentation and discussion.

7.1 The conventional agriculture in Chivi

Chivi is located between 19^0.50’ to 21^0.50’ S and 29^0.50’ and 31^0.50’E geographical coordinates (Chineka, 2016). The district is characterised by sandy loamy soils in an undulating terrain of 811meters above sea level (Makuvaro, 2014; Mafumbabete *et al.* 2019 and Kudengera, 2019). Chivi lies in the least rainfall agro-ecological region five of Zimbabwe, with an annual precipitation of 450mm (Mapfumabete *et al.* 2019). The area is also characterised by frequent droughts (Mudzonga, 2012; Chineka, 2016 and 2019).

Agriculture in Chivi is mainly small-holder farming with 28 wards practicing it on communal lands. Mixed farming is the main characteristics of agriculture in the district (Mudzonga, 2012 and Makuvaro, 2014). Almost every farmer in Chivi is involved in crop and livestock production. Crop production is done intensively on plots which range from one to three hectares using ploughs (ZimStat, 2013). Crop production is mainly for subsistence with surplus reaching the markets (ZCATF, 2009). Farmers mainly produce food crops such as maize, small grains and legumes (Mudavanhu and Chitsika, 2013).There is a strong link between livestock and crop production. Livestock provides draught power and manure, while crops provides livestock fodder. Livestock relies on communally owned pastures on village outskirts and farmlands during lean seasons such as winter.

7.2 The link between CA and the desired agricultural change in Chivi

CA has been widely endorsed as an antidote for low agriculture yields in Chivi (Gukurume *et al.* 2010). CA is perceived as a crop management system with a potential to conserve, improve and make efficient water and nutrient use (FAO, 2011). Wall (2007) defines it as a complex technology which consist of multiple components ideal for smallholder farming. It is viewed as viable land management tool in agriculture which is based on enhancing natural biological processes above and below the ground (Friedrich and Kienzle, 2007) According to ZCATF(2009) CA is suitable for poor small holder farmers operating on rain-fed agriculture systems. All these characteristics describe Chivi community, hence its nomination by various NGOs as a participant in the CA project.

7.3 Results and discussion

7.3.1 Characterisation of household heads

The questionnaire was administered to 51% female household heads and 49% male household heads. Majority of household heads were within the 31-50years age range. Most household heads were married constituting 50%, with a 7.1% widowed and 17.1% divorced. Majority (58.6%) household heads had a secondary school qualification, with 2.9% never had no formal education. Unemployment was high, with 58.6% not employed against 3.6% employed and a 27.9% and 10% distribution of self-employed and pensioners respectively. Most household heads, thus 69.3% fall within the World Bank (2019) extreme poverty threshold, with a monthly income below US$228.

7.3.2: Household's social capital assets profile

Households had relatively big household sizes, with 49.3% having over five members (Table 7.1).

Table 7.1: Households sizes

Household size	Frequency	Percent
2 people	28	20
3-4 people	43	30.7
≥5 people	69	49.3
Total	140	100

Large household sizes are a proxy to farm labour (Mazvimavi, 2010). Hence majority of households have adequate farm labour, 65% agreed to this assertion 35% did not. Remittance inflows also build on resilience of the community, as 63.6% of households have family members working off family compounds. About 29% of households rely on remittances during droughts (Figure 7.1).

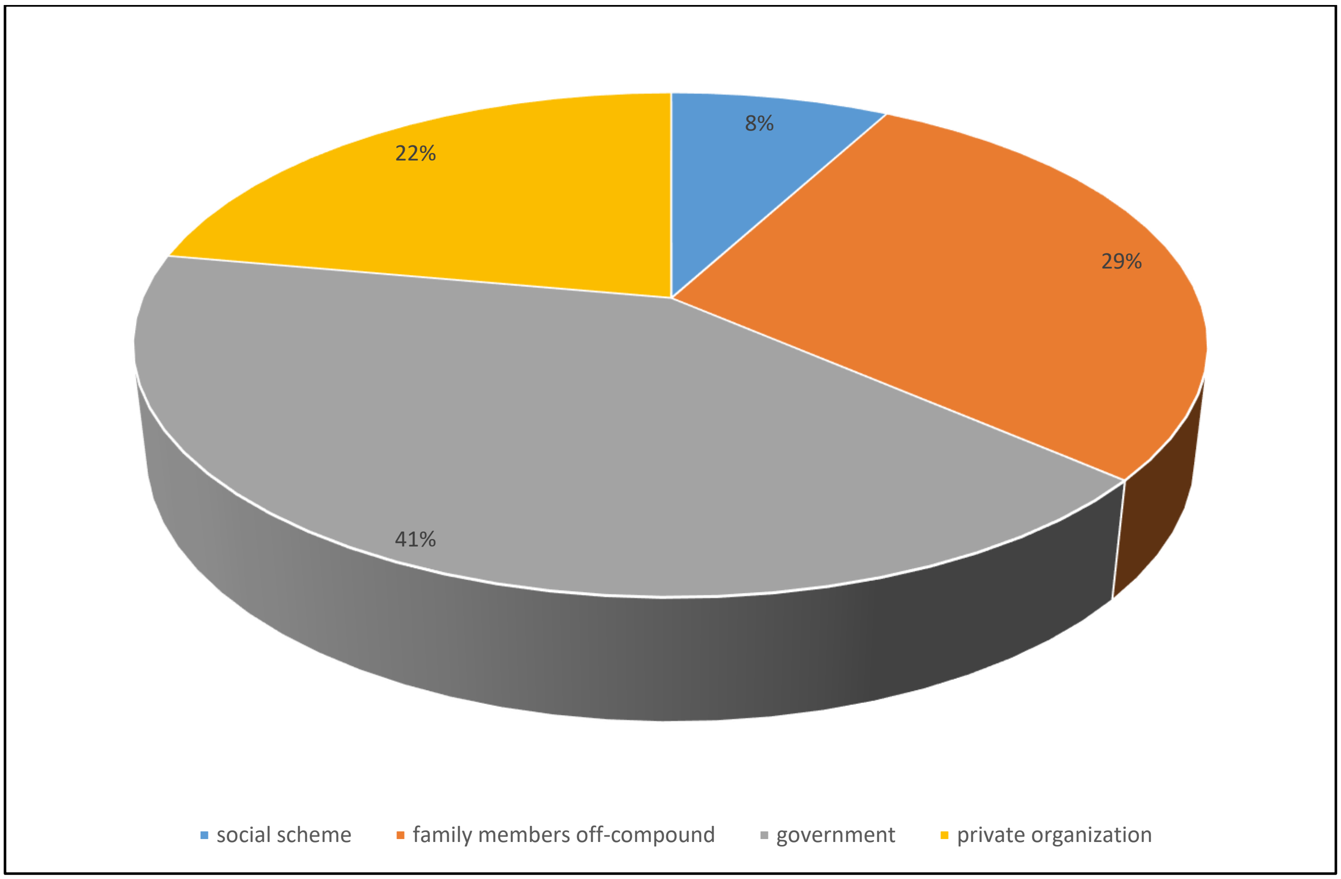

Figure 7.1: Source of drought relief

However the findings revealed that most drought relief comes from government. It is also important to note that social networks are also extensive as most households have family members working off-family compounds. Local social networks also exists, 45% of household heads affiliated to social schemes.

7.3.3 Physical and natural capital assets profile

Chivi community has access to land and pastures. All the respondents had land and livestock as assets. However the quality of soil is poor (Figure 7.2). Majority with an 88% of the respondents described their soil as poor. This was also supported by CA project officials and focus group discussions. Mafumbabete *et al.* (2019) and Makuvaro (2014)' studies on Chivi also had similar results.

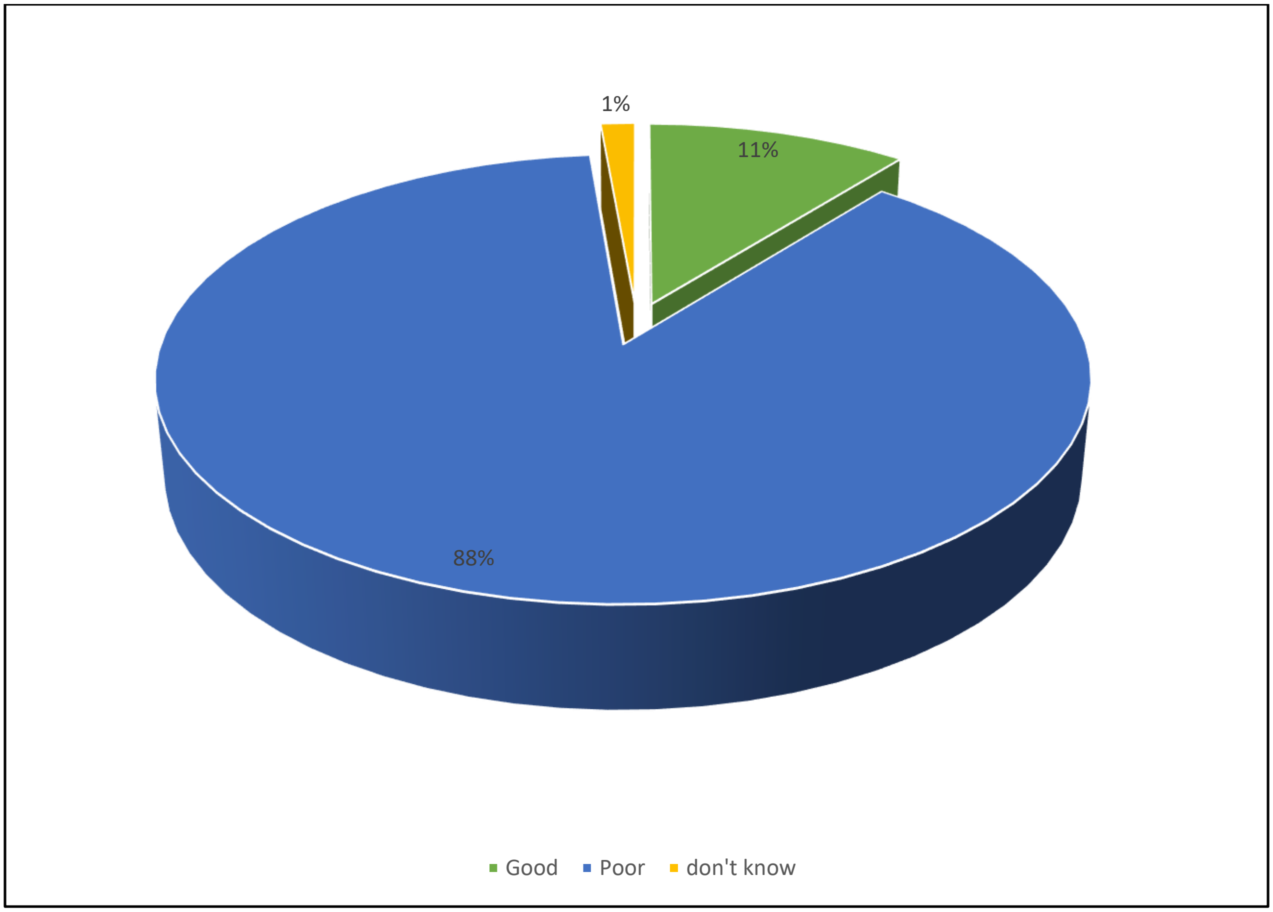

Figure 7.2: Soil quality

Besides soil quality, Chivi has also a challenge of agriculture water. All respondents depended on rainwater for agriculture, with very few having access to boreholes for domestic water. Rain fed smallholder farms struggle to maximise production especially in dry areas such as Chivi (ZCATF, 2009; Mudzonga, 2010 and Mazvimavi *et al.* 2010). Other resources not easily accessible are agriculture markets where farmers travel a mean distance of 22.8 km, 44km for banks and 7.7 km for agricultural extension services, refer to Table 7.2 below.

Table 7.2: Access to resources and services

Resources and services	N	Minimum (kms)	Maximum (kms)	Mean (kms)	Std. Deviation
Shopping Centre	140	1	9	3.6214	2.40867
Irrigation scheme	140	0	1	0.4071	0.49307
Agriculture markets	140	1	57	22.8857	18.60498
banks	140	7	85	44.0286	23.04201
Public transport	140	1	25	3.3893	5.82542
agriculture extension services	140	1	25	7.7643	6.6013

These long distances do not only affect the farmers' productive time but even the profitability of agriculture. Considering that CA targets female farmers, gender roles and inaccessible services can affect production.

7.3.4 Financial assets profile

Chivi households do not have sound financial assets, 63.6% of the respondents relied on savings (Table 7.3).

Table 7.3: Households financial assets

Financial assets	Frequency	Percent
savings	89	63.6
credit	36	25.7
social schemes	15	10.7
Total	140	100

While 25.7% used credits and 10.7% were under social schemes. These findings are similar to (Mudzonga 2012)'s findings when she used a logit model to assess farmers' adaptation to climate change in Chivi. However this study contradicts her conclusions that an increase in farmers' access to credits would increase their adaptability to climate change. Savings and credits are good in a stable economic environment. Considering the hyperinflation in Zimbabwe savings are easily affected as well as credits and social schemes. Most household heads monthly earnings were within the World Bank extreme poverty threshold of less than US$228. Non agriculture incomes and agriculture incomes were also below this limit. Livestock was the only reliable asset owned by most household herds (Table 7.4).

Table 7.4: Livestock herds

Livestock	1-5 Count (%)	6-10 Count (%)	11+ Count (%)	Total Count (%)
Cattle	3(2.1)	115(82.1)	22(15.7)	140(100)
Goats	23(16.4)	110(78.6)	7(5)	140(100)
Donkeys	72(51.4)	68(48.6)	68(48.6)	140(100)
Poultry	21(15)	88(62.9)	31(22.1)	140(100)

Focus group discussions noted cattle as the most reliable asset which could be easily liquidated during poor seasons. While livestock might offer that safety net, they are also affected during prolonged droughts. Mutasa (2011)' s study on drought coping strategies informs that though farmers might use livestock as safety nets, a single trajectory mechanism cannot yield sustainable adaptation.

7.3.5 Socio- economic impact of CA in Chivi

CA brought new skills and new knowledge to Chivi community. All questionnaire respondents practicing CA mentioned at least, new skills or knowledge as the major social benefits of CA. This was also supported by the farmer's adoption of the project. Though 98% of farmers who participated in the questionnaire did not adopt CA package onto their personal plots, all of them have at least adopted one of the CA principles in their conventional agriculture systems. Crop rotation and time management are some of the mostly adopted principles. Community members noted unity among farmers as the major impact of CA. Ward 24, 10 and 14 discussants raised this (Figure 7.3).

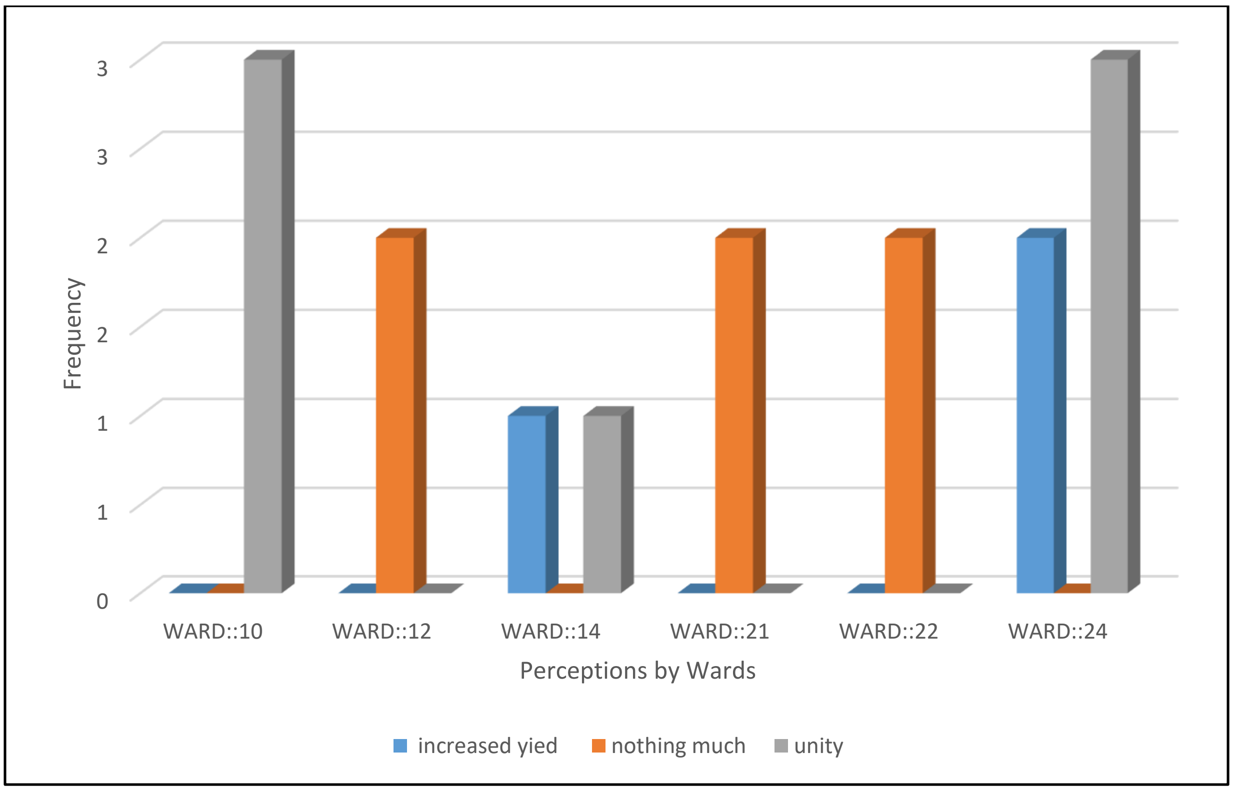

Figure 7.3: Perceptions on socio-economic benefits of CA in Chivi.

Ward 14 and 24 noted an increase in yields. The prime mandate of CA operations in Zimbabwe is to sustainably increase agricultural yields, thereby ensuring food security and enhancing climate resilience (ZCATF, 2009; Mugandani and Mafongoya, 2019). The other four group discussants did not support the view that CA helped the farmers increase yields. Key informants supported this view, they added that CA benefits have not been visible enough due to recurrent droughts. This again contradicts the assertion that CA, does well in below average rainfalls (Michler, 2019).

Focus group discussions also yielded mixed views on the social benefits of CA in Chivi. Ward 12, 21 and 22 did not confirm any socio-economic benefits of CA. These discussants argued that CA was not a new skill to them, but the 'oldest form of agriculture which was practiced before civilization'. Unity was total dismissed. The verbatim that surrounded evaluation of the social impact CA by group discussants was negative. There were social tensions between CA adopters and non-adopters over the perceived agriculture norms of the society, such as use of crop residues for mulching against stock feeds, barricading of communally owned farmlands, and use of basins which are a danger to livestock. Rusinamhodzi (2015)'s study on the social impact of CA in Murehwa, Zimbabwe, as well Gukurume (2013)'s study in ward 21 of Chivi noted this social tension. Non CA adopters had completely different views about CA, they dismissed that the project had a value to the society. The bone of contention as observed in Ward 22 and 21 was CA project replacing food relief and also the labour intensive nature of CA. Narratives which characterised the arguments included,

"*Gore rezhara hapana wakamborarama ne Dhiga udye tose tongoforera mukomondera naivo varimi ve diga udye.*"

Which is a Shona translate to "during the drought season, we all queue for food relief including the CA farmers, it has no benefit to us". Key informant interviews with AGRITEX officials also supported these findings. CA system is also vulnerable to drought, yields deteriorate during dry seasons. Michler (2019) assessing the performance of CA and climate resilience in small holder farming systems, noted that one size does not fit all in CA. Even though CA proved to be a useful tool in Australia and America in Sub-Saharan smallholder systems across 729 households in Zimbabwe, it did not yield the anticipated results. The study found out that CA does not do well with average rainfall, performs better with below average rainfall but that varied again with the crop variety. Giller *et al* (2009) conceded with Michler (2019), the study noted that CA benefits vary and maximum benefits are often realized in systems where there is a simultaneous application of all principles of CA.

Key informant interviews also listed improvements in food security in Chivi as one of the benefits of CA. Food security corresponds with an increasing agriculture yields. Production yields for Chivi does not show an increase. These findings supports studies by Makuvaro, 2014 and Christler, 2019. Comparison of CA and conventional agriculture productivity by Chivi community also showed that CA had not much difference in yields as compared to conventional (Figure 7.4).

Focus group discussants who had adopted CA agreed that CA has better yield per hectare. CA farmers who adopted the project also supported this view. The non-adopters of CA had a different view, they did not perceive any difference in yields between the two systems. CA was noted to be affected by drought and having low returns. Mango *et al.* (2019) assessing the impact of CA on food security in Zimbabwe, Malawi and Mozambique , using the potential outcomes framework also noted low impact of CA on food security in Zimbabwe. The study attributed this to failure of farmers to implement the whole package of CA. Focus group discussants attributed low returns to the small plots of CA and high costs of production.

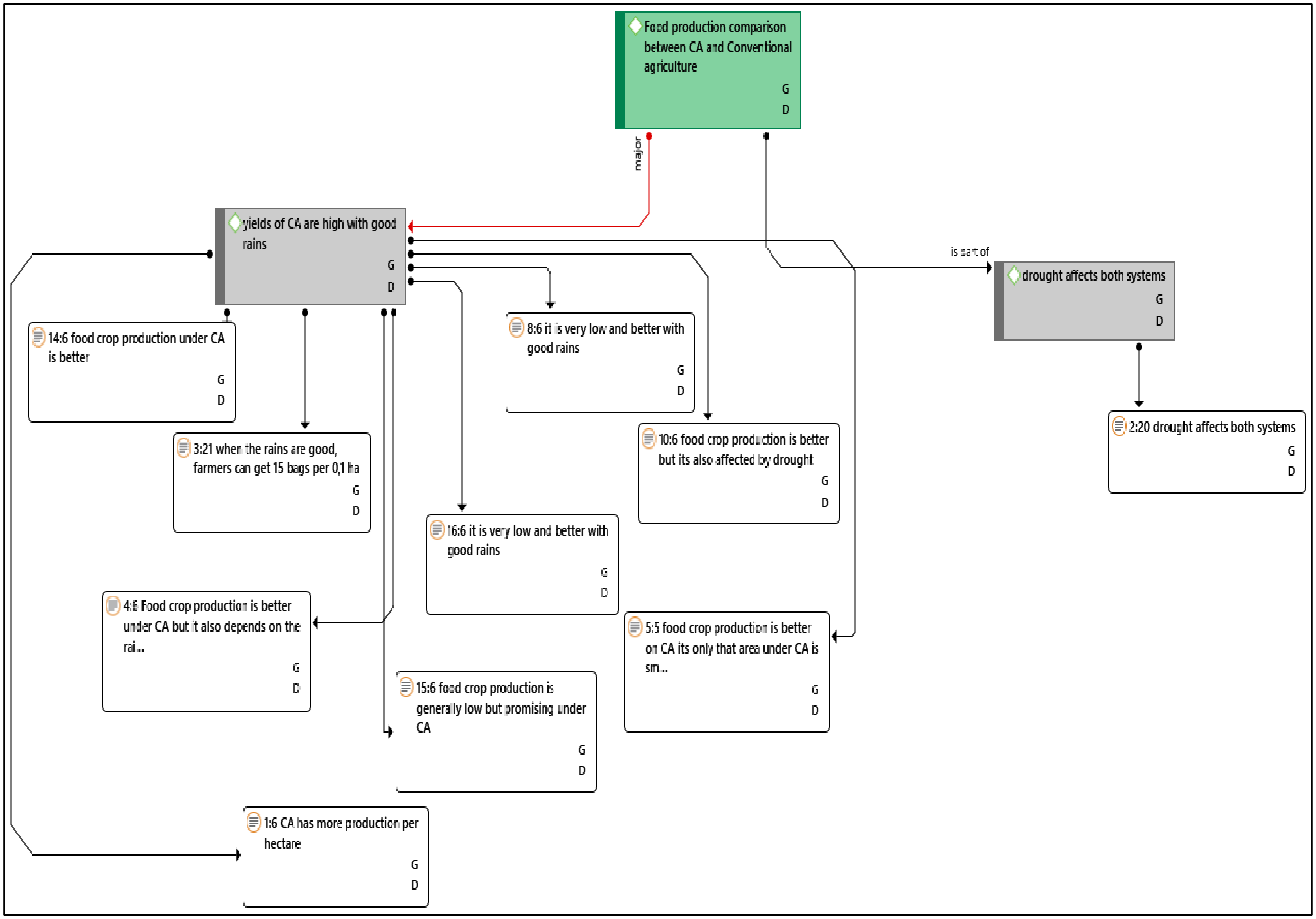

Figure 7.4: Comparison between CA and Conventional agriculture productivity

To ascertain the economic impact of CA, statistical difference of maize yields, returns from maize crop sales, cost of maize production, sales from other crops and their cost of production between CA and conventional systems was assessed. 82.7% of CA farmers yielded less than a tonne of maize per season while 17.3% had more than a tonne. Under conventional system 62.7% yielded less than a tonne and 37.3% got over a tonne of maize. Only 32% of questionnaire respondents earned over US$229 from maize sales, 68% got less than US$228, which is below the World Bank (2019) poverty datum line. Of these respondents, 80.7% spent US$150 on production costs of maize, while 9.3% spent more than US$200. This shows very little profit margins to net losses in some cases. In other crops, 62.7% of respondents earned less than the poverty datum line, while 80% of these farmers spent over US$150 in production costs. Considering time and labour involved in agriculture, these figures shows insignificant contribution of CA to the economy of Chivi. These findings contradicts Mazvimavi *et al.* (2010) in which CA systems in 15 Districts of Zimbabwe including Chivi yielded 1546kg/ha against 970kg/ha of conventional systems. The variation could be that CA in Chivi is done on very small plots and yields are shared between 15 to 30 group members per each plot. Droughts have also become more frequent and do affect yields. Findings from key informants showed that drought is eroding the benefits of CA in Chivi. However this assertion also contradicts the perceived benefits of CA, thus the system being climate resilient and doing well in below average rainfalls (Mazvimavi *et al.* 2010; Mango, 2017 and Christler, 2019). This also raise questions on the effectiveness of CA in semi-arid, small holder systems.

7.4 Summary

This chapter assessed the socio-economic impacts associated with CA in Chivi. The study used data from household questionnaires, supported by focus group discussions and key informant interviews. The household questionnaire was structured using the UK DFID Sustainable Livelihoods framework. CA‘s socio-economic impact was weighed as an outcome of CA against the households’ livelihoods scrutinised through the livelihoods capital assets. The theory behind being that households are heterogeneous and their livelihoods assets affect the outcomes of CA differently. Thus to say CA is operating on different domains of change and these domains depending on the nature of CA can improve or worsen livelihoods of the community. Findings revealed that CA has brought new skills to Chivi but tangible impact on the community is still minimal.

CHAPTER 8: A CONCEPTUAL FRAMEWORK TO ENHANCE EFFECTIVENESS OF CONSERVATION AGRICULTURE AS AN ADAPTATION STRATEGY TO DROUGHT

8.0 Introduction

CA initiatives are gaining momentum in southern Africa. In countries such as Zimbabwe, CA has been promoted across the country since 2003 (Zimbabwe Conservation Agriculture Taskforce, 2009; Mazvimavi *et al.* 2010; Marongwe, 2011 and Makuvaro, 2014). The Government of Zimbabwe and various international partners have invested in CA in a bid to increase agricultural yields and build climate resilience among the poor small holder farming systems (Mango, 2017). In districts such as Chivi, characterised by poor soils, erratic and low rainfalls, CA is perceived as a sustainable remedy (Nhodo *et al.* 2010 and Mugandani and Mafongoya, 2019). Despite the potential of CA and huge investments in its implementation, the adoption of the project remains low (Pedzisa *et al.* 2015). This chapter develops a conceptual framework to enhance the effectiveness of CA as a drought adaptation strategy in Chivi and other areas of similar environmental conditions.

Various NGOs are managing CA in Chivi and a concern has been raised on numerous extension service providers in Zimbabwean agriculture especially in the rural areas (Agriculture Research Council, 2002). Multi institutions which run CA projects, offer uncoordinated extension and cause confusion on the part of poor and less educated farmers (ZCATF, 2009). This led to the establishment of a Conservation taskforce in 2008, so as to control, standardize and harmonise CA operations in Zimbabwe (ZCATF, 2009).

It's not only the multi institutional model which affect agriculture productivity, even the extension approaches (Scoones *et al.* 2013). The government wing, AREX provides the technical support of the CA project in unison with various NGOs (Mazvimavi et al. 2010). CA in Zimbabwe has also been criticized for taking a top-down approach, common with many governmental projects (Nhodo *et al.* 2010 and Gukurume *et al.* 2010). In this approach, researchers and specialists are perceived as knowledge banks, hence they pass knowledge to passive farmers who in turn assimilate the information and apply it on their plots. According to Mukute (2013) such models are outdated especially considering the parameters within which agricultural systems operate. However in areas such as Chivi NGOs are now engaging CA farmers following a participatory learning approach (Agriculture Research Council, 2002 and ZCATF, 2009). Participatory models are built to instill a sense of proprietorship among the intended beneficiaries. Under this model the community is involved in learning about its needs and the available options and opportunities on a shared knowledge, interactive platform (Mukute, 2013). However not all participatory approaches yield effective results.

8.1 Shortfalls of the participatory approach

Participatory approach may or may not bring the desired change depending on the typology followed. FAO (2019) notes that participatory approach can fail to yield the desired change, if the following typologies are adopted.

Table 8.1: Shortfalls of participatory approaches

Approach	**Weakness**
Passive participation	Farmers follow laid out instructions from project administration, no capturing of their opinions
Participatory by consultation	Farmers participate only when consulted, no binding obligation to capture their views
Functional participation	Farmers participate in groups following predetermined objectives. As a result they become too dependent on facilitators
Interactive participation	Farmers participate in group/joint analysis. This results in action plans and formation of new local institutions and often take control and ownership over the local decisions It also involves the use of interdisciplinary methods, which needs multiple methodologies and make use of various learning methods
Self mobilization	Farmers participate by taking initiatives independent of external institutions to change. Such self-initiated mobilisation and collective action may or may not change the existing status quo and institutions

CA in Zimbabwe is mainly done under three, participatory approaches. According to ZCATF (2009) these include, Extension Agent system, where trained extension officers from either AREX or NGOs work with farmers. This is more of a top down approach. The second approach is the Lead Farmer approach, where trained staff work with lead farmers who will in turn pass the expertise to their groups. The last one is the Combined Extension Agent and Lead farmer which is the integration of the two systems. This involves staff working with groups of farmers then lead farmers will be chosen to lead groups in future. All these approaches seem to reduplicate a top down approach. Farmers work with preconceived knowledge and predetermined objectives. Gukurume *et al.* (2010) argue that NGOs running CA in Chivi have failed to move away from top down approaches. Despite the adoption Participatory Learning Approach in Chivi, CA adoption levels remain low (Mashingaidze, 2012). Cosmetic participation of locals has been noted as a hindering factor to effective adoption of CA in Chivi (Gukurume *et al.* 2010). Key informant interviews with the NGOs confirmed this assertion. NGOs got their baseline data for problem identification from secondary sources. That says a lot about farmers' interests' representation as well as their role in decision making.

Krishnan and Patnam (2013) note that though extension agents have immediate influence on productivity, there is more knowledge sharing in farmer to farmer approach. In their study in Asia, small holder farmers preferred to learn from their progressive peers. The findings of the key interviews with extension officers in Chivi supported this assertion. Freire's education models, the banking approach to education and empowerment education argues that the poor live in a "culture of silence dominated ideas and values of others instead of educational philosophy and practice to liberate and empower learners by ensuring consciousness of the world around them" (Grace and Wells, 2007). There is a need for an integration of farmers' knowledge about their environment to ensure effective adaption.

Bene *et al.* (2015) notes that a framework of any project may or may not be effective depending on its design and implementation. Habanyati *et al.* (2018) and Pedzisa *et al.* (2015) noted withdrawal of CA by farmers after adoption due to failure to mainstream their values and indigenous knowledge. Hivos (2015) theory of change (ToC) advocates for integration of people centered approaches. The theory argues that communities are not homogeneous, people have different and unconscious ideas about how the world and people should change. All this is shaped by their environment, beliefs and norms. Approaches which are more people orientated and recognize the spheres of domains through which the required change should occur are more likely to yield results (VLIR-OUS, 2019). Brown *et al.(*2017) in Livelihoods Platforms Approach concedes and adds that bottom up approaches, which strengthens the livelihoods capital assets of the community are more sustainable.

8.2 Adapt to Change Conceptual Framework

This study proposes the Adapt to Change Conceptual Framework (ACCF) to increase the adoption of new agricultural technologies such as CA, especially in small holder, mixed farming systems. This is an integration of Hivos (2015) Theory of Change and the DFID (1999) Sustainable Livelihoods theory.

The Adapt to Change Conceptual Framework consists of eight domains of change picked by this study as lines of weaknesses. These domains of change influence adaptation to drought shocks. Strengthening of these domains leads to effective adaptation and buildup of transformative capacities of the community. These are the areas on which change should be effected for total resilience, whether the communities are absorbing the shock or anticipating the shock.

Domains of change are classified as external and internal domains. Internal domains are the ones which influence adaptation at a household level and external are factors influencing change at a community level. External domains of change include institutional capacity, political influence, agency collaboration, access to basic services and extension models.

8.2.1 Institutional capacity

Institutional capacity is defined as the capability of an institution to set and achieve social and economic goals through knowledge skills, systems and institutions (ITDP, 2016). Institutions working on CA need to be strengthened. This could be done through following a more binding, blue print guide to CA operations, drafted and agreed upon by all stakeholders. Kassam *et al.* (2014) note that where CA is not supported by policy, private and public sector, adoption of the project takes long. The policy document should also clarify stakeholder structures and their roles. This would help in avoiding overlapping roles or gaps within project operations. Institutional capacity also speaks to strengthening of local institutions for community resilience. Clarification of roles among the project beneficiaries and monitoring of the local institutions built will see effective adaptation and transformation of communities in the face of droughts.

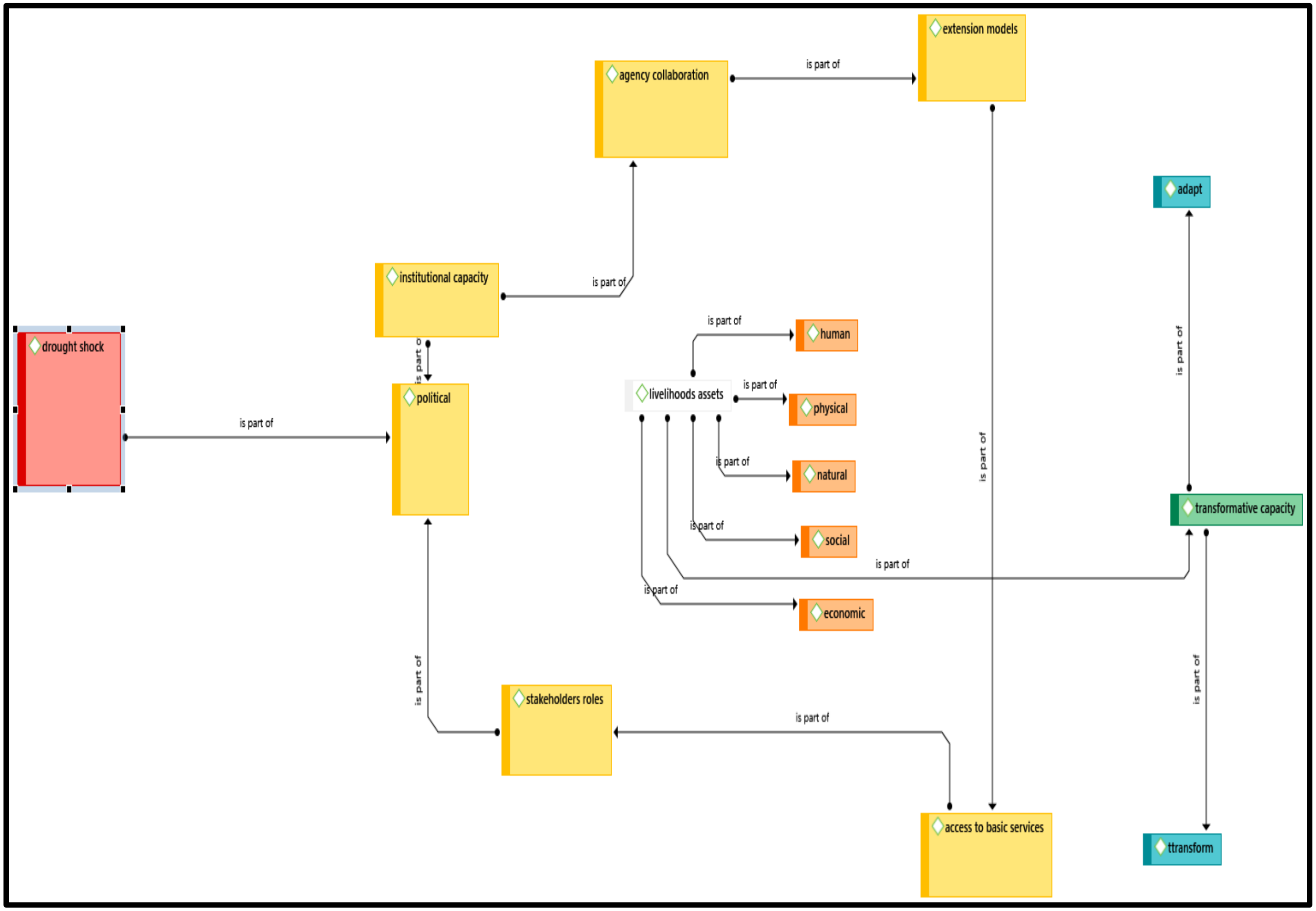

Figure 8.1: Adapt to Change Conceptual Framework, ACCF (Source: Author)

8.2.2 Political change

Politics play a crucial role in the agriculture sector of Zimbabwe. Hence effective intervention should win support of political structures. This speaks to coordinated political structures involvement in the project. CA has to be a national priority and due to its interdisciplinary nature there should a synergy between CA policies under different interlinking governmental departments (Jat *et al.* 2012). Policy coherence and compatibility with existing structures and approaches is key, to promote sustainable agriculture (Kassam *et al.* 2014). Effectiveness of CA depends on collaborative and supportive policies such as market, land tenure, purchase of agricultural implements and trade. Lack of collaborative roles and policies will erode the benefits of CA, weaken the project and adaptation of communities to drought.

8.2.3 Agency collaboration

CA agency should work in collaboration for effective resilience and quick adoption of the project. Multi-agency working in isolation with different models reduce the chances of effective resilience. Collaboration also will allow for effective monitoring of the project and sharing of ideas. Agency collaboration should include all stakeholders of CA including the suppliers and markets usually done by the private sector. Common understanding would lessen the burden of farmers as well as cutting down some costs of production. FAO (2013) notes the need to establish a stakeholder coalition for a shared vision and more harmonized CA operations.

8.2.4 Extension models

Extension is defined as agricultural systems that are used to facilitate access of farmers, organisations and markets to information, knowledge and technologies, thus interaction of agricultural partners. Its a policy tool for safe and quality agricultural production (Danso-Abbeam *et al.* 2018). This calls for effective extension models. Such models have clear and inclusive design, shows commitment and knowledge of extension providers, are people centered and consider not only one aspect of development but should be holistic thus covering economic, environmental and social dimensions (Ssemakula and Mutimba, 2011). Beneficiaries often have indigenous knowledge and better knowledge of their environments. They have their own perception of their desired change. It is within this breadth that extension services have to support the needs of the local communities by giving information which is more specific, site focused, user friendly and inclusive of local values and knowledge (Huq, 2011). Extension models which integrates this knowledge into their scientific technologies are likely to promote adoption and strengthen drought resilience unlike preconceived and predetermined models.

8.2.5 Access to resources

The other external domain of change critical in drought resilience is the access to services. Resilience projects such as CA use much of the communities' time. This becomes a burden if basic resources are not easily accessible. Inaccessibility of service can demotivates the community and struggle to adjust to the intervention. It also increases costs and erode the benefits of the intervention programme. Mutambara *et al.* (2015) note that land tenure has a major impact on agricultural productivity and adoption of technologies. Land needs to be more accessible to women who are major players in agriculture. According to FAO (2019) women continue to face major constraints particularly in access to resources. Yet availability of resources and services to beneficiaries contributes to effectiveness of agricultural technologies (Ssemakula and Mutimba, 2011).

8.2.6 Stakeholders role

Technology effectiveness has more to do with its users than its design (Giesing, 2003). Chivi CA having higher yields per hectare than conventional agriculture is an indication that the system is effective, hence it needs the targeted beneficiaries to be orientated towards the technology. This can only be done when the role of all stakeholders including the beneficiaries' roles are clearly stated. Passive participatory and farm leader participatory models reduplicates the evils of a top down approach. Gukurume et al. (2010) noted cosmetic participatory methods of engaging stakeholders as a line of weakness in Bikita's CA project. Freire (1968)'s pedagogy of the oppressed supports this and adds that the poor often learn in a culture of silence dominated by foreign ideologies instead of exploring their local environments for upliftment. Drawing up of clear stakeholders role will assist in avoiding duplicating roles and clashing of interests.

8.2.7 Human livelihoods assets

At the center of the ACCF model are the livelihoods capital assets, which influence resilience at a household level. According to FAO (2013) effective models are holistic and engage the pillars of agriculture, thus economic, environmental and social dimension which are the pillars of sustainable agriculture and form the founding principles of the Agenda 21 programme's approach on Sustainable Agriculture and Rural Development (SARD). These assets need to be strengthened in a holistic manner by intervention projects for a more effective drought resilience.

8.2.7.1 Human assets

The assets include human capital. This looks at an individual household's demographic characteristics such as manpower. Lack of manpower has negative influence on CA adoption, hence the CA model has to accommodate and cover that weakness. The asset also considers household size in terms of labour and resources sharing. The human assets also include employment status and off-family compound employment. Households with employed family members increase family's resilience to drought, while members employed off compound offer safety nets during a drought through remittance. Gender dynamics also affect CA adoption. Zulu-Mbata and Chapoto (2018) noted gendered difference in CA mechanised technological adoption, whereby male headed households adopted the ripper system more than women due to their lack of voice in decision making.

8.2.7.2 Social assets

Social assets refers to family networks and community networks which are very critical for the resilience of households. A household with wide social networks is better informed and can rely on these networks during a drought shock. Social networks are important, strengthen social interaction and increase informal finance opportunities (FAO, 2013). Culture, indigenous knowledge, values, equity, vulnerability, literacy and gender sensitive are crucial social assets (FAO, 2007). Community interventions should strive to strengthen these social assets for better resilience. Extension services should also aim to build social proximity of service providers and CA project beneficiaries. According to Ssemakula and Mutimba (2011) this could be done by building an information sharing platform where extension service providers and beneficiaries share a similar socio-economic background. This enhance free communication and interaction.

8.2.7.3 Physical assets

These are the tangible properties a household has for example livestock, plough, borehole and land. Lack of these assets weaken a household and if intervention does not strengthen these assets a household can struggle to adopt an intervention project and weaken its resilience. Strong physical assets gives a household a leverage to drought resilience. Access to land and water resources increase agricultural productivity (Mutambara *et al.* 2015).

8.2.7.4 Economic assets

Economic assets include the household financial assets, such as household income, food grown by a household, access to resources and non- agricultural enterprise and incomes (FAO, 2007). A household with high income has higher resilience to drought. CA or any project focusing on rural development should be site specific and matches the needs of the targeted households (FAO. 2013). However economic assets are directly affected by the economic status of the country. In countries where there is no economic stability, intervention should promote built up of fixed assets which appreciate in value. Therefore government commitment to building a stable economic base should be part of the policies. NGOs and the state have to work jointly to stimulate economic markets, provide markets for agricultural inputs and outputs and diversification of the economies from household to a national scale (FAO, 2013).

8.2.7.5 Natural assets

This entails the natural endowments such as climate, soils, terrain, forests and rivers, thus the environment. Environment is key in sustainable agriculture and rural development (Ssemakula and Mutimba (2011). Natural assets heavily influence household resilience. These assets are often shared at communal level, hence strong social networks between community members is critical for equitable use of these resources. Nhodo *et al*. (2010) noted a social strife over the use of planting basins and mulching in CA, in Chivi, a society which use farming fields as communal pastures during lean seasons. External knowledge should be built on the local knowledge of natural assets for sustainability. It is also important to note that all assets are equally crucial in building community resilience hence should all be strengthened for effective adaptation.

8.2.8 Transformative capacities

If intervention projects holistically strengthen external and internal domains of change, communities will adapt to drought shock. If transformation capacities are built within beneficiaries, communities can transform rather than just adapt to drought. Transformative capacities should entail creating adaptive spaces within the intended beneficiaries communities. This conceptual framework recognise the different pathways a project can take and notes that intervention which address different domains of change through which change has to occur can go beyond making communities resilient to drought risks but can transform communities.

8.3 Summary

This chapter developed a conceptual framework to enhance adoption of CA and increase its effectiveness as a drought adaptation tool. This framework was developed using Chivi as a case study. The parameters used in developing this framework was informed by this study's findings on CA in Chivi. Sustainable livelihoods theory and theory of change and relevant literature also supported this framework. This framework seeks to highlight the importance of identifying the domains of change within the community. This should be involving the community members. It also emphasizes the mainstreaming of local values and knowledge as well as strengthening of local institutions for communities to adopt interventions, adapt to drought and transform their communities.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

9.0 Conclusions

The main objective of this study was to evaluate CA as an adaptation strategy to drought in Chivi. The specific objectives included characterising the nature of CA in Chivi, evaluating the adoption of CA, comparing food crop production per hectare under CA and conventional agriculture, assess the socio-economic impacts associated with CA and subsequently to draw a framework to enhance effectiveness of CA Chivi and areas of similar environment. The study was based on Chivi, a Zimbabwean district which is located in agro-ecological region five, characterised by erratic and frequent below average rainfall. Agricultural production is very low, threatening food security. The government and various NGOs have invested in CA to build a climate resilient agriculture and enhance productivity.

This study concludes that CA in Chivi uses three main principles of planting basins, mulching and crop rotation. However the project is migrating to minimal tillage using the ripper system. Despite the ripper system cutting down labour required in CA, 77.3% of CA farmers who participated in the questionnaire pointed out that the system is expensive and 2.7% had challenges with the costs of the ripper tines. Though the ripper system cuts down on labour and still prevent the loss of the much needed top soil, its effectiveness in maintaining soil moisture and holding the soil in situ is questionable.

The study also concludes that all farmers using CA are working on demo plots, however all of these farmers have at least adopted one principle in their conventional farming system. Therefore, though CA might not be effective as a project, adoption of some principles in the conventional system might still strengthen conventional agriculture against drought and indirectly render CA system effective in drought adaptation. CA activities run throughout the year and hence impact on time management and conflict conventional agriculture activities and livestock husbandry. Time management is crucial in rural areas, especially where women dominate the agricultural sector. Women are already overburdened in their distinct gender roles, hence for CA to be effective it has to be more time sensitive. Gender was noted to have an influence on CA adoption, apparently majority of CA farmers in Chivi are women.

The CA project design in Chivi showed a narrow scoping of stakeholders and spheres of influence. The project excludes the community in particular, the non-CA farmers. This creates social tensions, breeds negative influences which adversely affect the project. Multi-institutions which manage CA lack coordination and its participatory learning extension excludes indigenous knowledge and values. This creates conflicts yet communities are interrelated social spheres which respond to a problem as a group and only react to challenges which fit their social problem status.

The study concludes that Chivi has a low CA adoption rate of 30%, with some farmers in ward 21 and 22 withdrawing from the project. Tradeoffs model describe farmers as rational beings, who only opt for a new system of agriculture if it’s more lucrative than the system already in place (Antle and Valdivia, 2011). Low adoption in this case, would mean, the CA system is not effective enough. The study also established that CA farmers are still working on demo plots, after more than 10 years since the introduction of CA. Yet CA benefits should be visible after 10 years (Mazvimavi, 2010; Pedzisa, 2016 and ZCATF, 2009). This study noted that CA has no tangible benefits to the community, hence its failure to capture the farmers’ interests. This shows that the CA project cannot cushion the community from drought effects. However this does not mean that CA, separated from the project is not an effective as a drought adaptation tool. Despite not practicing CA on their own plots, farmers have all adopted at least one principle in their conventional agriculture system. 80% of these farmers adopted crop rotation and the least adopted principles are planting basins and mulching. This could mean that though CA might be effective as a tool, there are other barriers to its adoption either in project design or implementation. The social buy-in of CA assessment revealed that 72% of the focus group discussants have a passive role in the CA project. Farmers and the community members in general are not clue less in the face of natural disasters, they have their indigenous knowledge and have their own view of their desired change in terms of drought adaptation. Failure to encapsulate this local knowledge and local values can affect the adoption of even an effective tool.

The study concludes that CA project in Chivi has a vibrant and comprehensive framework, which has the potential to increase food crop production in the district, basing on CA yields per hectare. However the model showed some weaknesses in its institutional and technical framework, which if addressed can enhance the effectiveness of CA as a drought adaptation strategy. Multi-institutions which administer CA in Chivi are not coordinated. NGOs operate on contract basis and roll out after exhausting their budgets and another NGO takes over. AREX which is a government wing responsible for agricultural extension and production in the country only assist with the extension services and do not manage or control NGOs activities. The agricultural extension system used in the CA project, though it follows a participatory learning approach, the typologies used such as the lead farmer learning approach and learning through observing still have the top down approach characteristics, which hinder effective adoption and effectiveness of the whole strategy as an adaptation tool to drought.

This study concludes that adoption of the CA project in Chivi is low, with some farmers withdrawing from the project in ward such as 21 and 22. For a strategy to be effective in the light of a disaster risk, it should cover all the affected people. Farmers are also still working on demo plots, which have increased to 180 baby demo plots from 18 mother demo plots. Failure to transfer CA to their own plots and resorting to increase demo plots reflects that farmers do appreciate CA but they are barriers which impedes practicing CA on their own farming land. Despite low adoption of the project, CA practices have advanced to traditional plots, all farmers have at least adopted a CA principle and incorporated it in their conventional agriculture. This supports the view that CA has the potential as a drought adaptation tool. Crop rotation and use of small grains are the most adopted strategies, while mulching and planting basins are the least. These least adopted principles could be the barriers to effective adoption of CA project and effective adaptation to drought. Other influencing factors to CA adoption assessed such as gender, age, level of education, employment status and incomes revealed that only gender and other non-agricultural income activities have a statistical significant relationship to CA adoption. The gender variable indicated that most of CA farmers are women. This then points out to the gender dynamics in Chivi as a society, such as land ownership and women's role in decision making, the effectiveness of their voices in disaster risks adaptation over CA as a project. Non-agricultural income generating projects also showed a statistical significant relationship to CA adoption. This support Antle and Valvidia (2011)'s assertion that farmers opt for a more viable agricultural option. Farmers who had lucrative projects such as selling woodcraft to tourists had a low CA adoption as compared to counterparts who sell firewood on the free time. Hence CA option might be effective at smaller scale and farmers do not perceive the benefits at a larger scale.

The study also conclude that farmers in Chivi rely much on their livestock, with 15.7% of farmers having at least a herd of 11 cattle. Hence Chivi practices mixed farming in which livestock is important in terms of its liquidity nature which is critical during drought. CA principles thus mulching and planting basins, which are least preferred in Chivi are in conflict with livestock husbandry. The fact that farmers opt for their conservative conventional system to protect their livestock shows that CA project is not viewed as effective as livestock production in the light of drought risks and adaptation.

This study concludes that maize is widely grown in Chivi. This is despite the view that the climate of this area is not suitable for maize production and drought resistant varieties such as sorghum and millet are being promoted by NGOs. Promotion of small grains was also mentioned by some farmers as the reason why they did not adopt CA. Comparison of maize and small grains revealed that small grains do better in Chivi than maize. Therefore though CA might be an effective adaptation tool it's affected by crop preferences of the community. Comparison of CA maize and small grains yield per hectare to conventional agriculture yields showed that CA have higher yields per hectare. Therefore CA boosts agricultural production which makes it effective as an adaptation tool to drought. CA project yields an average of 15 bags of maize per demo plot, the yield is shared amongst 15 to 30 members of group. Rationally this yield cannot sustain an average farmer let alone in the face of drought. The land under CA is too small for farmers to witness the benefits of CA.

On socio-economic impact of CA in Chivi, farmers learnt new farming skills and team work. The project had no other tangible benefits, visible to the community. The main argument of the Chivi community was that drought affect both CA and non-CA farmers equally and CA project officials blame the ineffectiveness of CA as a drought adaptation tool to poor project adoption by the community. The study concludes that CA as a concept separated from the project is effective as a drought adaptation tool and for the CA project to be effective it needs to capture the interest of farmers and boost the adoption figures.

9.1: Recommendations

The multi-institutional approach characterising CA operations is affecting the continuous and uniform progress of the project as well as compromising its adoption and subsequently its effectiveness as a drought adaptation strategy. Various NGOs run CA with their different partners. This results in the project being run under different models and time frames. NGOs roll out their operations haphazardly and are being replaced by new NGOs, this breaks continuity and progress of CA. This could be the reason after over a decade in operation CA farmers in Chivi are still working on demo plots. There is need for government to regulate and control the operations of NGOs in Chivi.

The study also noted weaknesses within the role of stakeholders in CA project, particularly the local community. The community's views and local knowledge is not integrated. The community is not fully involved in the Participatory Learning, extension approach used in CA. Findings revealed that pre planning of the project, thus problem identification and formulation of the desired change used secondary data. The community was never involved, hence they fail to identify themselves with the project. In Participatory Learning Approach, the community is learning foreign preconceived ideas. This leads to the clash of knowledge, hence the community has challenges with some of CA principles such as mulching and planting basins, which clash with their traditional farming knowledge. Chivi community values livestock, they are more resilient to drought than crops hence mulching and planting basins affect livestock husbandry. There is a great need to integrate the community values and views on the desired change.

NGOs, government and the community have to facilitate the integration of CA principles into a mixed farming set up. Chivi district community is under traditional chiefs, these are the custodians of land. Each of these chiefs has a vast piece of land reserved for "Zunde ramambo", a programme where every household of the community has to work on that land, produce will be managed by the chief, who will in turn give some of the produce to vulnerable households. CA could make use of that land, get everyone to witness its benefits CA at a larger scale. If the community work together a lot of valuable indigenous knowledge can enhance performance of CA and improve adaptability to drought.

The study findings also showed that CA adoption is very low and so is the social buy in, in some Wards such as Ward 21, farmers are withdrawing from the project. Considering that CA is in its second decade in Chivi, CA benefits should have been realized and more farmers could be adopting the project. The community's verbatim on CA such as "NGOs' plots" and "Trainers" echoes the failure of the project to integrate the community and its values. However the fact that some farmers have adopted some of the CA principles in their conventional agriculture systems sheds a green light to the potential of CA in Chivi. There is now a need to embed the community's cherished conventional farming systems with CA principles.

Socio-economic impact of CA revealed that CA has undisputedly brought new skills, team work and improved production per hectare. All these however have not translated to tangible benefits to the community such as improved food security and financial status. Chivi farmers are exposed to drought and heavily rely on rain-fed agricultural systems, with continuous rise in temperatures coupled with episodes of heat wave, alternative sources of agricultural water are needed. Storm dams can be built to assist with irrigation farming. Chivi lacks strong physical and financial capital assets hence CA partners could enlist these capital assets as domains of change, then work to strengthen these assets to enhance the adoption of CA and facilitate drought adaptation..

CA donors should continue to assist CA farmers with free inputs up until the farmers start to have adequate yields to sustain themselves. NGOs have to move away from one size fit all models. The economy and political climate of Zimbabwe need exclusive models which will fully support communities until the situation normalize.

9.2 Practical implications of the study

This study has yielded a number of critical practical implications, which can enhance adoption and increase the effectiveness of the project as an adaptation strategy to drought in Chivi and areas of similar environment.

CA adoption is very low. The institutional framework has failed to capture and integrate the community and its traditional values and knowledge. This could be a weakness in design or an overlook by project implementers. There is need for a more comprehensive framework which integrate the community in its model. Findings also noted various NGOs running CA in Chivi. This cause confusion on the part of farmers. It also compromise uniformity and hinder progress of CA. There is also a need for a more comprehensive, more binding, blue print code of conduct to harmonise CA operations in Chivi.

9.3 Areas of further research

Based on grey areas highlighted by this study such as the oblivion role of the local community in CA, uncoordinated roles of CA project services providers, Future studies can zoom more on the integration of local communities and indigenous knowledge in rural community projects. Research could also work towards drawing up of a comprehensive framework to harmonise operations of rural projects such as CA. Subsequently the effectiveness of some extension models such as Participatory Learning Approach and its implementation need to be looked into. There is also need to look into technologies which can support CA under recurrent drought conditions.

9.4: Limitations of the study

This study being based on primary and secondary data sources, its findings need to be understood from this perspective and context. Nevertheless the conclusions made can be used in areas of similar environmental characteristics and should be never generalized out of these contexts. The framework drawn in this study has not been validated. However it is based and grounded on well-established scientific theories.

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APPENDICES

Appendix 1: Household Questionnaire on Adoption of Conservation Agriculture

Dear Participant

My name is Chineka Jestina, a Ph.D student in the Department of Geography and GIS at the University of Venda. I'm doing a research entitled Conservation Agriculture as an adaptation strategy to drought in Chivi. The aim of this survey is to characterise Conservation Agriculture project in Chivi District and to establish the technological adoption of the project by Chivi community members.

This research is meant for academic purposes only and participation is voluntary, respondents can withdraw at any time. Respondents will not be exposed to any form of harm either physically or psychologically. Privacy and identity of the respondents will be safeguarded. This implies that the information will be kept confidential. No names will be captured in this questionnaire.

In case of any queries contact my supervisors, Dr H. Chikoore (+2715962 8586) and Dr N.S Nethengwe (+27 15 962 8593)

Please, Provide answers using a cross(x) in the appropriate box next to the question.

Village name [ ] **Questionnaire ID** [ ] **Date** [ ]

SECTION A: Demographic information

1. Sex

Male	1	
Female	2	

2. Age

Under 18	1	
18-30	2	
31-50	3	
51-60	4	
60 and above	5	

3. Marital status

Single	1	
Married	2	
Divorced	3	
Widowed	4	
Other		

4. Level of education

No formal education	1	
Primary	2	
Secondary	3	
Tertiary	4	

5. Employment status

Employed	1	
Self employed	2	
Unemployed	3	
Pensioner	4	
Other	5	

6. How much on average do you earn per month

≤$228	1	
≥$229	2	

Section B: Household human and socio-economic capital

1. What is the size of your household?

2	1	
3	2	
4+	3	

2. In your opinion, do you have enough farm labour?

No	1	
Yes	2	

3. Do you have any family members employed off family compound who support you?

No	1	
Yes	2	

4. During drought where do you get most support from?

Social scheme	1	
Family members off- compound	2	
Government	3	
Private organization	4	
None	5	

5. Are you a member of any social scheme?

No	1	
Yes [if yes specify]	2	

6. Other non-agricultural income generating projects

Gold panning	1	
Selling carvings	2	
Selling firewood	3	
Cross border trading	4	
Others	5	

7. On average how much income per year do you get from other sources besides agriculture?

$0	1	
≤ $2738	2	
≥2739	3	

8. Which financial assets do you have access to?

Savings	1	
Credit	2	
Loans	3	
Social schemes	4	

Section C. Physical assets information

1. How much distance do you travel to fetch household water?

>2km	1	
2 – 4 km	2	
<5km	3	

2. What is your main source of agricultural water?

Source		
Dam	1	
Rain	2	
River	3	
Borehole	4	
Rain	5	
Other	6	

3. How would you describe your soil quality?

Satisfactory quality	1	
Good	2	
Poor	3	
Don't know	4	

4. Which assets do you have?

Car/ scotch cart	Tractor	Plough	Livestock	Borehole	Electricity /Generator/Solar	Land
1	2	3	4	5	6	7

5**.** Which resources and services do you have access to?

Shopping centre	Irrigation scheme	Agricultural markets	Banks	Public transport	Agricultural extension services
1	2	3	4	5	6

6. How big is your livestock herd?

		Cattle	Goats	Donkeys	Poultry	Other	
1-5	1						
6-10	2						
11+	3						

7. Explain on livestock ownership in your family?

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8. How much money do you make per year through livestock and milk sales?

Milk	
Livestock	

9. How much money do you spend on livestock feeds?

≤$100	1	
$150	2	
$200	3	
$250	4	
$300	5	
$350	6	
$400	7	
$450	8	
≥$500	9	

10. Do you use manure from your livestock in your crop fields?

Yes	1	
No	2	

11. On average how many buckets of manure do you get from your livestock per year?

≥499	1	
≤500	2	

12. Do you have access to pastures?

Yes	1	
No	2	

Section D: Conservation and Conventional Agriculture

1. Are you a Conservation Agricultural project farmer?

Yes	1	
No	2	

2. Why
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3. How did you become a member?

Chosen	1	
Volunteered	2	
Other(specify)	3	

4. Besides being a farmer what other role do you play in the Conservation agriculture project?

None	1	
Participate in decision making	2	
Other(specify)	3	

5. How long have you been a Conservation agriculture farmer?

≤3years	1	
≥4 years	2	

6. Which technique did you adopt?

Application of mulch	1	
Digging of basins	2	
Application of manure	3	
Weed control	4	
Application of fertilizer	5	
Crop rotation	6	
Other	7	

7. Which Conservation Agriculture techniques are challenging and why?

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8. How much maize yield do you get per hectare/ season under Conservation Agriculture?

≥21 bags	1	
≤20 bags	2	

9. How much maize yield do you get per hectare/ season under Conventional Agriculture?

≤20 bags	1	
≥21 bags	2	

10. How big is your farm land?

Football pitch size	Twice football pitch size	Three times	Four times
1	2	3	4

11. How big is the land you use for Conservation Agriculture?

Half football pitch size	Football pitch size	Twice football pitch size	Three times
1	2	3	4

12. How much money on average do you get from maize crop sales every year?

≤ $228	1	
≥ $ 229	2	

13. How much do you spend on maize production?

≤$100	1	
$150	2	
$200	3	
$250	4	
$300	5	
$350	6	
$400	7	

$450	8	
≥$500	9	

14. How much money on average do you get from other crop sales every year?

≤ $228	1	
≥ $ 229	2	

15. How much do you spend on the production of other crops?

≤$100	1	
$150	2	
$200	3	
$250	4	
$300	5	
$350	6	
$400	7	
$450	8	
≥$500	9	

16. What do you use your crop residue for?

Livestock feed	1	
mulching	2	

17. How have you benefitted from being part of Conservation agriculture?

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18. What challenges are you facing in conservation agriculture?

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19. How is conservation agriculture better than conventional agriculture and vice versa?

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20. Are you planning on extending your farming area under conservation agriculture?

Yes	1	
No	2	

21. Why?

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22. Which other drought coping strategies does your family use?

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23. In your opinion what could be done differently to achieve the goals of conservation agriculture in your area?

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Appendix 2: Key Informant Interview: Logical Framework review Checklist

Conservation Agriculture: Project Monitoring and Evaluation Officer

- What was the desired change, why and for who?
- Who could assist in reaching this desired change and how?
- What was the situation in relation to the problem(s) you wanted to tackle?
- How these problems were causally linked to each other?
- Who are the stakeholders? What is their role in the current context?
- What stake do they have in the project? How will the project involve / engage them?

Problem analysis

- The context which shapes the project i.e. historical, social, political, economic, cultural, ecological and geographical parameters
- Definition of the framework and subject of analysis (scope);
- Identification of the major problems faced by target groups and beneficiaries (What is/are the problem/s? Why is it a problem?), and the broader context in which these problems occur.
- Does the problem analysis give due attention to the general context, environmental issues (analysing the environmental context and its links with socio-economic issues) and gender issues (analysing the way in which the situations/needs/challenges of men and women differ in relationship to the problem).

Stakeholder's analysis

Feasibility analysis:

- Available know-how, capacities and interest of the stakeholders
- Complementarity with other actions
- Priority
- Best value for money
- Effect in terms of (gender) equity (does the strategy respect the principles of inclusive development)

- Environmental relevance (does the strategy respect the principles of sustainable development).

Mapping the pathways of change backwards from the desired change and the "domain(s) of change"

- What needs to happen before the next positive step in the change process can take place?
- How do we think the change process might evolve?
- What needs to change for the desired change to occur (and: why?).
- Will the change process – or elements of it – work out differently for men and women?
- What elements of your pathways of change are within your sphere of control? Sphere of influence? Sphere of interest?
- What are the key risks of the project and what are the most important assumptions the formulation is making about the pathways of change?
- General recommendation: Look back, review and fine tune after each step

Identifying and manage the key risks the project will potentially face

- What are the key uncertainties, assumptions risks?
- What is the probability the risk will occur (or: the probability the assumption is not valid)
- What is the potential impact of the risk
- If needed: how can you reduce the potential impact of the risk or reduce the probability of the risk occurring?

Developed indicators

- What information is used to track and analyse the change process as it evolves?
- What information is used to monitor assumptions or learn about the change process?
- What information is used to demonstrate the realisations of the project?
- How is information collected, how often? What systems are in place?
- Why are they important?
- Who measures indicators and the importance of alignment

- At what levels do we formulate and measure indicators?

Operationalise – plan activities

What activities need to implement to deliver the intermediate results?

- When do you need to implement them?
- What means? Who is responsible?
- What management activities are needed to guarantee a smooth implementation?

Appendix 3: Key Informant Interview Checklist: NGOs Extension Officers

1. The name of the monitoring and evaluation tool (framework) used in CA project

2. Agricultural yields in tonnes/ha over the years under CA

3. CA adoption figures in terms of number of farmers over the years (trends)

4 .Number and size of initial demo plots and any increases/ decrease in acreage over the years

5. What can you say have been the social and economic benefits of CA

6. Which wards is CA being effectively practiced; rank them in terms of adoption levels

Appendix 4: Key Informant Interview Checklist

Extension Officers

- When was the project implemented?
- How did they decide on areas to include in the project
- Who are the stakeholders of this project?
- How is this project managed?
- How does the community participate in the project?
- Food crop production trends
- Amount of land under CA against conventional agriculture and its trend
- Costs involved in CA farming as compared to conventional farming
- The levels of project buy in by the community
- The sustainability of the project

Appendix 5: Focus Group Discussion Checklist

Chivi District community members

- The nature of Conservation Agriculture in Chivi?
- Origin of the CA project?
- What problems were farmers experiencing under conventional agriculture?
- How was CA project introduced in Chivi?
- What role does the community play in this project?
- Why did some people join and others not?
- What does the project entail?
- Which technology have the people adopted?
- How has the community benefitted from CA socially and economically?
- What challenges are they facing under CA?
- Are there any gender based challenges associated with CA?
- How many farmers have increased the land under CA from the initial demonstration plots?
- If few, why are they not increasing their plots?
- What difference in yield are they witnessing under CA and Conventional farming?
- What benefits have the farmers accrued from CA?
- In your opinion how best can the community adapt from drought?