

DECLARATION

I Gotoza Nyasha, declare that the research project is my own work and has not been written for me by any other person(s). It is submitted for the degree of development studies at Midlands State University.

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APPROVAL FORM

The undersigned certify that they have read and supervised the student Gotoza Zivengwa Nyasha dissertation entitled: **The contributions of conservation agriculture towards food security in Zaka District**, the project submitted in partial fulfilment of the requirements of Bachelor of Arts Honors Degree in Development Studies.

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**DISSERTATION TITLE: THE CONTRIBUTIONS OF CONSERVATIONS
AGRICULTURE TOWARDS FOOD SECURITY IN ZAKA
DISTRICT**

**DEGREE TITLE: BACHELOR OF ARTS HONOURS DEGREE IN DEVELOPMENT
STUDIES (HDEVS)**

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Signed.....

Student

Date.....

DEDICATION

I dedicate this dissertation to my parents Mr. and Mrs. Gotoza, my mom Bianca Banda and my lovely wife Sharlene Nyamutswa

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Firstly, I want to thank God the almighty who granted me strength, guidance and unlimited grace till the accomplishment of my study.

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ABSTRACT

Conservation agriculture has been promoted and implemented as solution to enhance crop productivity, which in turn leads to food security and as a poverty alleviation mechanism among communal farmers in Zimbabwe, Zaka district in particular. Primarily this research is focusing on assessing the contributions of CA towards food security in the whole of Zaka district. This research presented CA as a multifaceted solution to food insecurity problem in Zaka District. Quantitative research method is employed in this research. Reviewed empirical literatures have shown that, despites its documented paybacks, the adoption trends of conservation agriculture by communal farmers have hick ups but from 2009 to date adoption trends reached a constant level even the adoption rate is still low. Full success of CA in promoting food security in Zaka is threatened by a plethora of factors, the major one being financial challenges to access sophisticated CA inputs that may limit labor intensiveness associated with the technology as shall explained in chapter 4. However, findings of the study have shown that CA beneficial contributions in the district outweighs its challenges. Food security is multidimensional phenomenon which can only be achieved by fulfilling its complex aspects which are food availability, access, stability and affordability of safe healthy nutritious food. CA improved yields in the district by 50 to 100% with other CA plot harvesting more than the expected 250 kilograms per 0,25ha.

LIST OF ACRONYMS

AGRITEX	Agricultural Technical and Extension Services
CA	Conservation agriculture
FAO	Food and Agricultural Organization
ha	Hectare
HH	Household
ISALS	Internal savings and lending
NGOs	Non -Governmental Organizations
SAT	Sustainable Agricultural Trust
SSA	Sub Saharan Africa
WFP	World food program
ZCATF	Zimbabwe Conservation Agriculture Taskforce

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CHAPTER ONE

PROBLEM AND SETTINGS

1.0 Introduction

This dissertation investigates the contribution of CA towards the attainment of food security in Zaka District of Masvingo province in Zimbabwe. CA is being promoted widely as a panacea for poverty alleviation and improvement of the food security sector. CA is a technological option that can increase agricultural productivity of a wide range of crops by resource poor farmers even in drier agro-ecological regions. Farmers across Zimbabwe showed a growing interest in CA technology with evidence of yield gains of between 10 and more than 100% depending on input levels and experience of the farm household, Mazvimavi et al (2008). The ministry of Agriculture, mechanization and irrigation have since hailed the importance of CA to that effect, (Sunday mail 16 June 2012.) After severe food shortages in 2002 and 2008 in Zimbabwe renewed CA efforts came with donor intervention in 2003 and 2009 respectively, contributing through training of smallholder farmers and constant supply of inputs. Due to poor harvest witnessed in conventional farming, farmers resorted to receive and adopt CA in Zaka based on three basic principles which are minimum tillage, mulching and diversifying crop rotations. However, recently the adoption rate deteriorated and practice of CA is still perceived to be low in communal areas, AGRITEX (2011) hence the continuity of food insecurity in Zaka district.

CA is an effective way of conserving the environment especially in communal areas where the environment is threatened by degradation in the face of climate change. Zaka district is susceptible to climate change and other factors which affect food security. The district is naturally located in dry region; it experiences high food shortages since last decades. The district is also a typically

and largely smallholder dry land farming area. The soils are generally unproductive with most sandy- loamy.

Based on the perceived benefits of CA, the past decade witnessed a number of conservation farming methods being introduced in Zimbabwe which however are yet to be fully adopted. It offers an opportunity for poor vulnerable households with no access to draught power to produce more grain per unit area thus, households with full draught power are better off even if rainfall is below normal Twomlow and Levis (2006). Climate change experienced in the district is threatening the food security situation especially for the vulnerable poor communal people. Climate change adaptation must be taken as a major priority to ensure food security. In this regard, CA came as an adaptation measure which should be adopted to combat the adverse impact of climate change. CA potentially increases crop yields and reduce production cost making it an important technology contributing towards food security in Zaka District. Therefore, this study seeks to assess the contributions of CA in promoting food security in Zaka.

1.1 Background of the study

CA or MT has its origins in the US Dust Bowls of the 1930s. The government of America supported farmers to quit their traditional way of farming (conventional) and to adopt no tillage/ minimum tillage, so as to solve the problem of soil degradation, soil infertility and low yields. In the 1940 seeding was developed to seed direct in the soil without much soil disturbance. With the notable advantages CA began to spread widely over Europe In 1982 in Spain no tillage found to be advantageous in terms of soil recover, moisture retention and yield increase Geraldez et al (1994). In an endeavor to solve food insecurity problem, CA experiments were held in France INRA and ITCF mainly with cereals and began to gain momentum nationwide. Some farmers developed superior no till system with green manure cover crops and crop rotations (Derpsh,

2010). CA has been gaining popularity all over the world over the past three decades and applied on about 95 million hectares Derspsch, (2005). Together with other organizations and other stakeholders FAO has been promoting CA in several countries in Latin America, Africa and Asia so as to improve food security.

After a notable increase in climate change, food security became threatened worldwide. It is alluded that SSA is the driest region of all n most susceptible to climate change and food insecurity. Most countries in SSA suffer severe food shortages to sustain their increasing population and the poor majority suffers hunger and malnutrition. Despite the reported benefits of CA its wider up scaling in SSA is fairly limited (Ndah et al, 2013). Notable adoption increase was noticed in Berkina Faso because of its sand to loamy texture which is highly fragile thus according to (Zida, 2011). Malawi and Zambia are also at the fore front of implementing CA.

In Zimbabwe CA was first implemented by Brian Oldrieve at Hilton estates in north Eastern Zimbabwe in the late 1980s Oldrieve (1993).In Zaka District, CA program was introduced by care international in 2005. Other NGOs joined the program later on operating in different wards of the district these include Plan International, Care, SAT and Caritas. Influx of NGOs targeted Zaka because of its vulnerability to food shocks and frequent food shortages. As a result, the district regularly receives food aid with the communal farmers being the most susceptible to food insecurity due to their inability to produce enough for subsistence. Zaka district falls into agro-ecological region 4 and more often receives erratic low rainfalls measuring 450-650ml, ZIMVAC (2017) consequently the area experienced seasonal droughts thereby its failure to feed its population of 181, 301 of which 98 948 are females and 82 352 are males according to (ZIMSTAT ,2012).

1.2 Statement of the problem

Zaka district is experiencing prolonged food shortages due to a plethora of variables the major one being low agricultural productivity against rapid population growth thereby, failure to produce enough food to feed its human population. Climate change, weather vagaries and land degradation are affecting agricultural production hence, food insecurity in the Zaka. The key reasons for low agricultural productivity are deteriorating soil fertility as postulated by Donvan and Casely (1998), dysfunctional input and output markets and the unfavorable macro -economic environment. The response to this crisis has been the wide scale relief distribution of food aid and direct agricultural input assistance without an exit strategy for sustaining some of new technologies promoted within the context of relief aid (DFID, 2009). This has led to a call on a need to focus more on sustainable crop production techniques aimed at improving soil fertility and environmental protection. One technological option for promoting soil fertility, water management and environmental protection has been conservation of soil water nutrients and farm power using a variant of CA techniques. CA was introduced to play a critical role to address food insecurity problem in Zaka District.

1.3 Theoretical framework

The conservation model developed in the time of English agricultural revolution supported by classical economists such as Malthus, David Ricardo and John Stuart was employed. The model postulated that land for agricultural production is scarce and becoming so. The model promulgated that soil exhaustion and possible actions to prevent decreasing yields or to increase land productivity will have a slow effect at best as land scarcity increase. The model went on to allude that poor land is used causing the marginal productivity. The model argues that to forestall these declines high priority should be given to maintaining soil productivity at its present level or to return soil to its original. Integrated crop, livestock husbandry is suggested because livestock will

provide manure. To this end food security can only be achieved by maintaining soil productivity which can only be achieved by conservation techniques. Thus CA is the best available sustainable technology than can boost food security at the same time being environmental friendly.

1.4 Objectives

The major objective of this study is to review the contributions of CA as a drive to achieving food security in Zaka district

Specific objectives

1. To assess the adoption trends of CA principles and practices in Zaka District
2. To identify household determinants factors which significantly motivate the adoption of CA in Zaka District
3. To Assess major achievements of CA practice towards food security in Zaka District
4. To assess CA implementation detriments in Zaka District

1.5 definition of terms

CA- is an approach to managing agro-ecosystems for improved and sustained crop productivity and increased profits while preserving and enhancing the resource base and the environment. CA is no tillage based cropping system (Kassam et al, 2009). The term is used interchangeably with terms like no tillage, minimum tillage, zero tillage, sustainable agriculture and organic farming among others. It is a management system based on the three basic principles that should be applied in unison in a mutually reinforcing manner namely:

- ***Zero tillage/no tillage*** – farmers are encouraged to reduce the intensity of soil tillage, or suppress it altogether thus, minimum soil disturbance through tillage (just enough to get seed into the ground) No till farming practice can save soil organic levels allows the soil

to be productive for longer periods of time (FAO ,2007). Thus conserving the environment. However, ‘minimum soil disturbance’ can be applied as sometimes some little cultivation is required for weed control, mulch management and seed bed preparation

- ***Mulching*** – refers to Maintenance of permanent or semi -permanent soil cover (using either prior crop residue or specifically growing a cover crop for that purpose). Mulching helps in managing the top soil to build a permanent organic soil cover (mulch) that can allow growth of organisms within the soil structure. It entails covering the soil surface completely and continuously throughout the year. Mulch layer keeps the temperature low and moisture at higher level. The breakdown of the mulch over time produces a high organic matter level which acts as a fertilizer for the soil. This will be beneficial especially to poor communal farmers who may not afford synthetic fertilizers
- ***Diversifying crop rotations*** to combat the various biotic constraints. It is premised on rotating growing more than two crop species in the same field. Crop rotation can be used best as a disease control mechanism which helps to minimize yields due to pest and diseases (Hobbs et al, 2007). Crop rotations also fixes soil minerals that are nitrogen, potassium and phosphorous.

Food security refers to a state at which all people, at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life, World Food Summit, (1996). The definition entails that food security can be explained by a combination interrelated elements, which are food availability, access, utilization and stability.

1.6 Significance and Justification of the study

Zimbabwe's largest population resides in rural areas depending on agriculture as their major livelihood strategy for both subsistence and commercial farmers with almost 70% of women being smallholder farmers (Chaguta, 2010). New technology like CA needs more attention since the topic is controversial among scholars as to whether CA brings about food security or not. However, this study is going to be of great importance to many CA stakeholders in Zaka as shall be explained below;

Community- findings of the study will be a true reflection of the effects of CA at district level, so by surfacing its impacts on food security will help increasing community awareness about CA. Hence, the adoption rate may increase at ward and district level, consequently crop productivity and yield increase at district level.

Other researchers – they can utilize findings of this research as both a source of information and reference.

Government – the study is going to be a torch bearer to the government and influence policy formulation, for example by understanding the gaps in CA and its major benefits towards food security, the government may restructure its budgetary policies to invest in CA for the country's food security.

AGRITEX –Findings of this study will add on to what they have thus coming up with comprehensive coping and mitigation mechanisms that will help the community at large. This will also assist them on devising educational lectures to farmers in their operational areas since they will be fully aware of the specific problem at hand.

Farmers- findings from this study will allow farmers to be aware of multi-faceted benefits of CA at both household level and district level.

1.7 Delimitations

The research is confined to Zaka district where the researcher had more access to information from various CA farmers. Zaka district is one of typical and largely smallholder dry land farming area usually hard struck by food crisis due to decrease in crop production. The district highly promotes CA as a mechanism to curtail frequent food shortages. The study dealt with both CA and conventional farmers for the purposes of comparison. The researcher arranged specific meeting points per ward, thus 3 meeting points were arranged in wards 4, 5 and 10 and every respondent was interviewed in his or her specific ward meeting Centre.

1.8 Limitations

Precipitation lessened attendance rate since respondents had to walk long distances to the designated meeting points. Some stakeholders failed to attend interviews and questionnaires due to work tight schedules thereby, indirectly forced the researcher to depend on their reports. Apart from that, the AGRITEX officers and department of mechanization officers who operated in ward 4 and 10 were transferred to other districts and some were retrenched hence they were no longer available therefore, the replacements lacked in depth knowledge and understanding of the program from where it started. The researcher then interviewed some other 2 AGRITEX officers worked in neighboring ward 3 since they made CA exposure visits. Despite the fact that the researcher made it clear that the information is for academic use some farmers were protective to produce sensitive information like how many meals they take per day? And how many livestock they own per household? Social reasons were behind such a protective nature since the district is well known for scandals of witchcraft “social beliefs”

1.9 Ethical considerations.

The researcher sort permission from the district responsible authorities to venture into the district such as the DA, Chief, ward councilor and village heads. He respected cultural, religious and political ideologies in the district. Respecting cultural and religious values did not provide a challenge to the researcher since he worked in the district during his internship under Caritas Masvingo. The research was based on informed consent of the farmers. The researcher avoided sensitive issues so as to guarantee respondents privacy and confidentiality. This is in line with Nancy Walton's thinking that, in research ethics first is to protect human participants.

1.10 Chapter summary

Chapter one pointed out the problem and its settings stipulating the background of the study, objectives, theoretical framework, problem statement, significance and justification of the study, delimitations and limitations of the study. The aim of this chapter was to give an overview of the research and to show how the researcher intends to solve the research problem. The next chapter is going to focus on literature review that is information gathered from other scholars.

CHAPTER TWO

LITERATURE REVIEW

2.0 introduction

This section focused on the previous researches conducted on CA in relation to food security exploring knowledge gaps and variance in perception which formed the basis of the current study. The chapter also reviewed the concept of CA adoption determinants and its contributions towards food security. Therefore, the sole purpose of this chapter is to identify and address loopholes left by other researchers.

2.1 theoretical literature review

CA is a multifaceted process. Dynamics in CA potentially affects farmer's uptake and willingness to adopt its practices. It is important to launch a theoretical base to model the relationship between factors that affect adoption of CA and adoption status of CA. since farmers are rational consumers of agricultural innovations and are able they to choose innovation packages that give maximum utility. However, it is important to understand cognitive and behavioral factors that influence adoption decision to provide a backup to conservation models.

Cognitive theories explain that adoption is like an action and is triggered through the uncomfortable tension which comes from holding the contradictory thoughts in mind at the same time. A farmer will have to choose between continuing with old conventional methods of farming or start using new methods. Internal state factors such as motivation, problem solving, decision making and thinking and attention will become critical on the adoption decision. Behavioral theories are based on the idea that uptake is a behavior which is acquired through conditioning. It helps adopters to learn new skills and behavior.

The theory of behavior modification by Albrecht et al. (1978) reviewed drivers that limit uptake of CA into inhibiting forces which negatively affect behavioral change (practice of CA) these forces include lack of subsidies, limited finance for labor hiring buying herbicides and other essentials. Driving forces refers to all inputs necessary for positive target (full practice of CA and improved yield). The factors include financial assistance, technical advice, training, provision of inputs and market linkages. However, the researcher observed that the theory lacks environmental insight that is it left behind environmental factors that are also essential in influencing farmers decisions on which farming method to use and which crop to grow. Therefore, the omission of environmental factors by Albrecht et al. (1987) led to the promotion of this study in which the researcher would like prove how critical environmental factors are for the success of CA towards food security. With the environmental factors identified the researcher hope the gap will be narrowed.

Feeder and Umali (1993) are of the opinion that risk aversion is an important factor explaining adoption of a technology package. Farmers tend to be risk averse especially those with limited asserts, own small pieces of land and with limited financial capacity. These farmers are exposed to severe risks and are inclined to adopt less risky components of the agricultural innovations. The “safety first” approach by Limpton (1968) shows that small farmers will use less of the specific technology per hectare because their subsistence requirements per hectare are higher than those of farmers with larger farms. The small farmers are reluctant to undertake “experimental farming” so they take time to adopt new agricultural innovations. The effect of uncertainty can also be minimized by adopting innovation in a steep wise fashion. It can be argued that farmers who adopt some of the components of the technology incur few costs rather than those who adopt the full

package. However, in refuting the above theory the researcher feels that CA practices are highly complementary and farmers will not fully benefit from adopting only one practice.

Furthermore, according to Mr. Zvemahara a farmer quoted in the Herald (2011) argued that CA is labor intensive. Mr. Zvemahara seems to have concluded that the intensity of labor is homogeneous to both males and females. However, in line with the biological theory of gender, men have more physical strength compared to their female counterparts. Thus the article can be questioned since it did not unravel gender disparities among men and women in partaking CA. Therefore, the question to answer is do women and men suffer same labor pain in partaking CA and who are the most active in partaking CA?

2.2 EMPIRICAL LITERATURE REVIEW

2.2.1 Adoption determinants of CA

There is a controversy among scholars on CA adoption rate, pros and cons of the technology. According to Griller et al (2009) CA adoption in SSA is low due to socio- economic conditions in which CA is implemented and CA can only improve food security in SSA if farmers have access to herbicides and fertilizers. That is to say a household with a stable economy and better socio conditions (healthy individuals, good interaction) will easily practice CA in contrast to other households. By considering the link between socio economic conditions and CA Griller did well. Nevertheless, it is essential to understand that there is a huge nexus between politics and development endeavor therefore, by focusing on economic conditions alone the scholar missed the other part that politics influenced Ca adoption particularly in Zimbabwe where most development projects are intertwined with politics therefore, the researcher is keen to unravel how politics can be an adoption determinant factor.

Large households are better placed to adopt conservation tillage than households with few members. This is because preparing the fields requires weeding and digging basins which is labor intensive. This was confirmed by Musara et al (2012) in Zimbabwe and Mukuen et al (2007) in Kenya. Thus Household size is a key factor given the labor intensiveness of CA. However, some communal households may not depend on family labor but can also hire it depending on financial permanence and liquid assets ownership. This assertion was proved by Bongor (2001) in Zimbabwe where household size and asset ownership were strongly connected but slightly impacts positively on the speed of adoption and practice of a technology.

2.2.2. CA governance and food security

CA can only improve food security in SSA if farmers have access to CA inputs Gowing and Palmer (2008). Of course the scholar managed to outline how CA can bring about food security in terms of provision and availability of fertilizers and herbicides. However, the current researcher feels that there is still a gap since the above researcher turned a blind eye to legal policies and framework that can render success to CA to bring about food security. This was supported by ACT in Tanzania that in Africa, investment in agricultural extension services is a critical component towards achieving food security under CA. However; it has been reported as lacking coordination. He noticed that the ratio of public extension workers to farmers is 1:3000 in developing countries whereas it is 1: 400 in developed countries (Mukomwa, n.d). This variation between developing and developed countries is attributed to the absence, weak enforcement of a legal and a policy framework especially in Zimbabwe for providing extension services. This includes low budgetary allocation towards CA due to economic crisis. Therefore, the researcher found it necessary to review this gap and give recommendation which he thinks if they are put into policy, properly

designed and well implemented they can improve CA productivity hence food security can be achieved.

CA improves crop production. Hasane et al (2000) evaluated the effect of planting basins and the use of fertilizer and manure on millet crops in Niger. According to their finding after five years of study farmers realized yield gains up to 511%. In Zambia farmers who use planting basins and crop residue on cotton achieved about 56% of their yields. However, the researcher felt that it was quite unfair to judge CA productivity focusing only on drought resistant crops as in the case of Niger and Zambia where millet and cotton were used respectively. Therefore, the study evaluated CA yields in Zaka District focusing on maize crop unlike cotton and millet which are already drought resistant crops.

Mazvimavi et al (2008) reviewed challenges which stand to the detriment of the success of CA in achieving food security in Zimbabwe. Some of the challenges Mazvimavi mentioned include that CA is labor intensive. CA requires weeding to commence as soon as weeds appear and an average of 2-3 times weeding per farming season. Another challenge is on mulching which is affected by low production of biomass in smallholder farmers which limits farmer's ability to meet a minimum recommended mulch cover of 30% cover. However, a loophole was noticed as Mazvimavi did not mention about lack of reinforced and enforced bylaws which are affecting farmers' adaptation to some of CA components. In most rural areas Zaka included, there are no bylaws to protect CA plots. These bylaws must be there to limit the extent of grazing on crop land after harvest. In Zaka district livestock is allowed to graze anywhere freely after the harvest period because there are no adequate reserves or paddocks for livestock grazing. A case study of Amaru District in Tanzania shows that the tradition is to let animals graze freely in fields after harvest. During dry seasons pastures get scarce forcing grazing to extend to crop lands. Therefore, by identifying this gap the

researcher is interested in presenting how destroying soil cover by grazing stands to the detriment of CA towards food security. Also to recommend on how the available limited bylaws can be reinforcement to protect the land canopy.

2.3 food security definitions and dimensions

Food security has many diverse interpretations, making it obligatory to spell out precisely what is meant here by food security and explain eloquently its various dimensions. Food security can be defined as below:

It is access for all at all times to a level of food sufficient for an active and health life, World Bank (1986). Alternatively Eicher and Staatz (1987) defined food security as the ability of a country or a region to assure, on a long- term basis, that its food system provides the total population access to a timely, reliable and nutritionally adequate supply of food. More so, according WPF (2013) people are considered food secure when they have availability and adequate access at all times to sufficient, safe, nutritious food to maintain a healthy and active life. World food first pointed out that food security exists when all people, all times, have access to and can afford enough nutritious and culturally appropriate food of their reference.

The researcher noted a plethora of food security definitions but of interest was the above two definitions. Scholars above do agree that food security revolves around aspects of food accessibility, availability, utilization and stability. However, the last two definitions differ when the last mentioned elements of affordability and culturally appropriate food which the first definition missed. In line with the last definition from the world food first the researcher agree that food security is when food is available, accessible and cultural appropriate. Thus if a country or

international aid provides or donates food that is not culture appropriate the researcher feels that there will be contributing to food insecurity.

Moving on, the researcher felt that the aspect of ‘safe food’ spelled out in the WFP (2013) food security definition is crucial in determining how secure food is. Safe and nutritious food is the one that builds a healthy being. In line with this argument USDA (2010) describes food desert which refers to a location that has limited access to healthful nutritious food especially in low income neighborhoods. For instance, individuals from ward 5 Zaka may have easier access to fast, unclean food and junk food than fruits and vegetables. Thus the aspect of availability and access to healthy food is essential to food security.

2.4 Aspects of food security

Food availability:

According to WFP (2018) food must be available in sufficient quantities and on a consistent basis. It refers to stock and production in a given and capacity to bring in food from elsewhere, through trade or aid. Food availability addresses the “supply side” of food security and is determined by the level of food production, stock levels and net trade.

Food access

It denotes regular acquisition of adequate quantities of food through purchase, home production, barter, gifts, borrowing and food aid. Access can be divided into two categories that are ‘Economic’ and ‘Physical’ access to food. An adequate supply of food at the national or international level does not in itself guarantee household level or individual level food access.

Food utilization

Consumed food must have a positive nutritional impact on people. It entails cooking, storage and hygiene practices, individuals' health, water, sanitation, feeding and sharing practices within a household. Utilization is generally understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals.

Food Stability

Food stability entails access to adequate nutritious food on a daily basis. For instance, if one's food intake is adequate today and inadequate access to food on a periodic basis one can be said to be food unstable risking deterioration of nutritional status. Adverse weather conditions, political instability and economic factors (unemployment, rising food prices) affect food stability.

2.5 Chapter summary

An overview of most literature on the contribution of CA shows that factors like access to extension and proper legal framework to govern CA most likely positively affect outputs of CA. However, factors like gender, education, off-farm employment, experience and age among others potentially affect CA practice and its contribution towards food security either way. Most evidence provided by different empirical studies on the success of CA is therefore mixed. In addition, the variable used in various researches cannot be generalized to affect the contribution of CA in all areas because of area-specific differences. Therefore, reviewed literature in this section shows that household, farm-level characteristics, institutional and socio-economic factors affect CA contributions towards food security.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the research methodology and stipulates the sources of data, how it was gathered and analyzed. The chapter therefore, seeks to discuss the methodology used in inducting this research highlighting the research design, study setting, sampling type, data collection tools and data analysis. According to Kothari, (2004) methodology involves procedures of describing, explaining and predicting phenomena so as to solve a problem; it is the ‘how’ of conducting research.

3.1 Research design

It is a plan or a framework used for analysis and collection of data. According to Kothari (2004), research design is a plan, a roadmap and blueprint strategy of investigation conceived so as to obtain answers to research questions; it is the heart of any study.

Quantitative research design was adopted in order to determine the relationship between the two variable conservation agriculture and food security. In this study it helps to evaluate how CA is a contributing tool to food security in Zaka district. Thus follows a descriptive/ observational study. Hopkins (2008) stated that descriptive study only establishes association between variables and the relationship is expressed using effect statistics, such as correlations, relative frequencies or differences between means. Quantitative research is all about quantifying the relationship between variables Hopkins (2008).

Case study

Case study technique was employed in this research. Gerring (2009) defines a case study as an intensive study of a single unit for the purpose of understanding a huge group of synonymous units. The researcher employed the case study technique referring to other studies in order to understand the contributions of CA and how they can lead to food security. The author was exposed to real life situations which made it easier to explain differing to experiments. The collected data was examined within the actual situation in which activities take place, in this scenario the researcher interacted with the farmers resulting to reliable primary data. In this case, a phenomenon is not isolated from its context as in the case of experiments. Nevertheless, case studies have their limitations.

3.2 Sampling procedure

Sampling is the process of selecting units from a population of interest so that by studying the sample we may fairly generalize results back to the population from which they were chosen. According to Miriam Webster dictionary (2018) Sampling is the act, process, or technique of selecting a representative part of a population for the purpose of determining parameters. The current research adopted stratified random sampling.

Zaka district has more than 6 wards practicing CA. However, the research chose to go to Wards 4, 5 and 10 where there are more farmers practicing CA. The study adopted stratified random sampling to acquire information from organized and suitable stratum. In this research a sample of 204 farmers was sought out of the 1000 farmers' population Zaka district. Stratified random sampling was used by the researcher because it is less time consuming.

3.3 Stratified random sampling

A stratified sample is a mini-reproduction of the population. Before sampling, the population is divided into strata of importance for the research. For example, by gender, age, type of farming method practiced social class, education level, religion, etc. Then the population is randomly sampled within each category. To this end the researcher used 4 strata which are a stratum of CA adopters, stratum of non- adopters, stratum of AGRITEX and Care officers. This was so because the researcher wanted to have a deeper understanding of the concepts, practice and benefits of CA. On the other hand, he wanted to have a clear comparison of CA and conventional tillage.

3.4 Target population and Sample size

Target population generally means members of a group in which a study is interesting. The main focus was upon C.A farmers in Zaka district however, for the purposes of comparison non CA adopters were also included. According to Caritas MISEREOR review report of January (2017) wards 4, 5 and 10 has got 1000 CA farmers. Research scholars argue that the larger the sample the more accurate the results become. 204 respondents were used. To come up with such a sample size the researcher used a sample size calculator using the following and also the following formula:

$$\text{Necessary Sample Size} = (Z\text{-score})^2 * \text{StdDev} * (1 - \text{StdDev}) / (\text{margin of error})^2$$

The population size was 1000, confidence level was 80% .and the margin of error at +/- 4.49% and 0.5 standard deviation

$$\begin{aligned} & ((1.28)^2 \times .5(.5)) / (.049)^2 \\ & = (1, 6384 \times .25) / .0449 \\ & = .4096 / .0449 \\ & = 203.17 \\ & = 204 \text{ respondents needed} \end{aligned}$$

This sample size fits the Roscoe (1975) criteria that for most research, a sample size of between 30 and 500 is appropriate and allows generalizations to be made to the study area. This is because a too small sample will not be representative while a too large sample may be too inconvenient to handle which reduce its efficacy. It must be noted that in case of this study and its scope increasing sample size has no difference in results because the geographical location of the area of the study is characterized with same climatic and environmental conditions

3.5 Data collection methods

Data collection instruments were explained by Brent et al (2005) as tools used to collect data from correspondents in the study. Primary and secondary sources of data were used in conducting this research. Primary sources refer to the original work of the researcher. To obtain the primary data the researcher used structured questionnaires and administered structured interviews. Secondary sources of data refer to the information which was gathered and presented by other researchers which was used by the researcher to back up statements, arguments, analysis and provide evidence in presenting opinions. These include journals, articles, documentaries, dissertations and web sources among others. This tool is significant in this research, since it advocated for visiting of past documents on the subject matter and gives the researcher platform to compare different literature.

According to Hair, Bush and Otrinau (2000) a questionnaire is a formalized framework which consists of a set of questions and scales designed to generate primary data. The researcher issued 204 questionnaires to farmers and extension officers. The questions aimed at tracing the trend of CA adoption, HH adoption determinants factors, success contributions of CA towards food security and CA implementation challenges. The respondents were asked to tick their views

against the statement. Nevertheless, the use of questionnaires came with limitations, some of the questionnaires were not returned, others were spoiled such that researcher regarded them as unreliable to consider.

3.6 Covert observations

Field Observation According to Mc Daniel and Gates (2001) is a systematic process of recording the behavior patterns of people objects and occurrences without questioning or communicating with them. The researcher employed field observations as he undertook a comparison between CA plots with Conventional. Field observation improved the practical knowledge of the researcher, since maize from Conservation plots looked healthier and promising better yields than those of Conventional plots which experience nitrogen deficiency and stunted growth.

3.7 Chapter summary

This chapter explained the research design and methodology. Questionnaires and, interviews, observations and were discussed. Participants interviewed were those relevant to provide information on the research topic. The researcher opted for stratified sampling in choosing participants. Observation was critical as it gave the researcher the opportunity to get a deeper understanding of how C A has been contributing to food security in Zaka District.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

The aim of this chapter is to present, discuss and analyze primary and secondary data obtained from the research on the contribution of CA towards food security in Zaka District. The chapter also focuses on the response rate, demographic characteristics are presented. Thereafter findings of the study are presented and discussion of the study lastly the chapter ends with a summary.

4.1 Response Rate

Response rate refers to the ratio of the completed questionnaires to the number of distributed questionnaires. Out of a target sample of 204 individuals, 160 questionnaires were successfully completed. Hence the response rate is expressed in form of percentage where the number of responses in the sample is expressed as a fraction of total sample size in this case 78% responded.

4.2 Data analysis

The data was then analyzed manually using standard deviation, Mean and percentage. Tables, pie charts and graphs were used to present the findings.

The following are formulas used to calculate mean and standard deviation.

$$SD = \sqrt{\sum \frac{(x-x)^2}{n-1}}$$

(2) Mean

$$M = \frac{x_1+x_2+x_3+x_4+x_5}{n}$$

4.3 Adoption and practice of CA in Zaka district

Adoption of CA is centered upon a number of variables which are gender, Cost advantage, labor availability, off farm employment status, NGO support, farm size, number of livestock owned, yields, and net returns.

4.3.1 Descriptive statistics

This section delivers a descriptive analysis of the sample socio-economic characteristics. The analysis aids to suggest possible statistical relationships between the explanatory variables and adoption of CA.

Distribution of sample by CA adoption status

The adoption status of farmers showed that above half of the population in Zaka did not adopt CA. out of 160 sampled farmers, 87 had not adopted CA and this signifies 54.37% of the sample. 73 farmers had adopted CA and this represents 45.62% of the sample. Therefore, a lot of meaningful effort has to be put to realize incremental adoption of CA since the level of adoption is still low

Table 1 Summary statistics for the continuous variables

	Mean		Standard deviation		Minimum	Maximum
	Non adopters	Adopters	Non adopters	Adopters		
Age	41	41	13.7	11.4	18	82
HH size	3	6	1.2	1.4	2	9
Livestock	8	6	6.1	4.6	0	30
Edn	13	13	2.87	2.97	7	18
Farm size	0.3	0,6 ha	0.14	0.17	0.1	1
Ext	8	21	6.86	6.38	0	36
Exp	0.3	0.6	0.14	0.17	2	50

The mean age for both adopters and non- adopters was 41 years. The minimum and maximum ages of sampled households were 18 and 88, respectively. The mean age of adopters is the same as that of non -adopters which may imply that age have little influence on adoption of CA.

The mean household size for adopters is 6 members while the mean household size for non-adopters is 3. The lowest household size of all households sampled is 2 while the maximum is 9. The difference between the household sizes mean shows that bigger households are more likely to adopt CA than smaller households.

The highest number of livestock per head is 30, while some households do not have livestock at all. The mean livestock per household for adopters is 8, while that for non- adopters is 6. The differences between the means may suggest that having few livestock may be positively associated with adoption of CA.

The table also shows that mean number of extension visits for the past 3 years on the part of non-adopters is 8 times while for adopters is 21 times. The minimum number of extension visits is 0 and the maximum is 36. Difference between the two means may imply that households with more access to extension visits are the ones who may be better placed to adopt CA.

The mean for experience is 16 years for non- adopters and 25 years for adopters. The minimum household head farming experience is 2 and the maximum is 50 years. The difference between the average years of experience for adopters and non- adopters is suggestive of a positive relationship between experience and adoption of CA.

Household farm land sizes ranges from a minimum of 0.1 units (0.4 hectares) to a maximum of 1 unit (4 hectares) per household. The mean household farm size for non- adopters is 0.3 units (1.2

hectares) while that for adopters is 0.6 units (2, 4 hectares). The difference between the farm size averages may suggest that households with large farmland are in a better position to adopt CA.

The minimum number of years of formal schooling is 7 years while the maximum years of formal schooling is 18 years. This shows that all the respondents had at least completed the primary level of education. The average years of formal schooling are approximately 13 years for both adopters and non -adopters. The similarity of the two means for adopters and non- adopters seems to suggest that education of household head have no significant impact on adoption of CA.

Table 2: Distribution of sample by adoption status and off farm employment status

	Off farm employment status of farmers		
Adoption status	Employed	Not employed	Total
Adopters	22(30.134 %)	51(69.863%)	73(100%)
Non –adopters	43(49.425%)	44(50.575%)	87(100)
Total	65 (40.625%)	95(59.375)	160(100%)

From fig 2 above, 65 farmers have off farm employment whereas 95 do not (40.625% and 59.375% respectively). However, out of the 95 farmers who had no off farm employment, 51 (53.684%) had adopted CA while 44 (46.316%) had not. On the other hand, out of the 65 farmers who had off farm employment, 22 (33.846%) had adopted CA while 43 (66.153%) had not. The figures show that most CA adopters have no off farm employment whilst most farmers who have off farm employment are non -adopters. These statistics are suggestive of a negative correlation between availability of off farm employment and adoption of CA.

Table 3. Distribution of sample by adoption status and membership to local organizations

	Membership to local organization		
Adoption status	Non –members	Members	Total
Adopters	29(39.73%)	44(60.27)	73(100%)
Non –adopters	45(51.72%)	42(48.26%)	87(100%)
Total	74(46.25%)	86(53.75)	160(100%)

From the above fig (3), 86 farmers belong to at least one local organization while 74 do not associate with any local organizations. These figures transform into 53.75% farmers with membership to a local organization and 46.25% for those with non-membership. Out of the 74(46.25%) farmers who did not belong to any local organization, 29(39.73%) had adopted CA while 45(51.72%) had not adopted. On the hand, out of the 86(53.75%) who had membership to local organizations, 44(60.27%) had adopted CA while 42(48.26%) had not. The table shows that more of the adopters belonged to at least one local organization and they may have acquired the information about CA from local organization. On the other hand, more of the non -adopters did not belong to any local organization and this might have limited their chances of learning principles and practices of CA. These statistics are suggestive of a positive association between membership to local organizations and adoption of CA.

Table 4 Distribution of sample by adoption status and gender of the farmer

	Adoption by Gender		
Adoption status	Female	Male	Total
Adopters	59	14	73
Non –adopters	34	53	87
Total	93	67	160
Percentage	58.125	41.875	100

Table 4.2 shows that, out of 160 sampled farmers, 93 were females which represents 58.125% of the sample. Male headed household were 67 which represent 41.875% of the sample. Out of the 58.125% women captured in the sample, 59 (63.4%) had adopted CA while 34 (36.6%) had not. On the other hand, out of the 67 male headed households included in the sample, only 14 (20.9%) had adopted CA while 53 (79.1%) had not. This implies that men have not well accepted CA. Therefore, being a male farmer may have a negative association with adoption of CA in Zaka district as results proved that females adopted CA more compared to male counterparts. This follows the argument that C.A in Zaka is highly feminized due to a wide range of factors including migration of man and off farm employment status of man.

Fig 1: CA Adoption trends

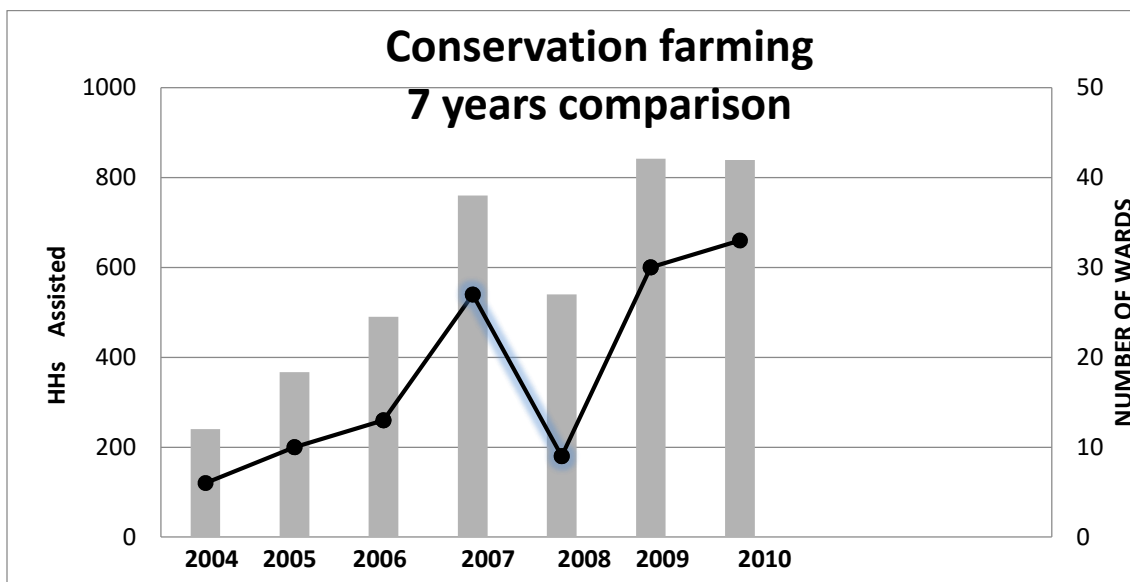


Figure 1 | CA trends in Zaka 2004 to 2010 Note: Number of HH and wards where CA was practiced. Source: primary data

Trends presented in fig 1 shows a notable increase of number of households and number of wards practicing CA from 2004 to 2007 due to increased NGOs support in terms of direct and technical

CA inputs. However, a decline was noticed in 2008 the period of economic crisis in the country and political upheavals. During that period many NGOS were banned by the ruling government for political reasons. Experiencing such a case many farmers started to run out of inputs and some migrated to neighboring countries in search of greener pastures. Such a situation is deemed responsible for the 2008 decrease of HH and wards practicing CA in the Country. Nevertheless, an increase was noticed again in 2009. Such a favorable increase can be attributed to better political economic conditions in the country where dollarization was introduced and a number of NGOs were allowed to operate in different parts the country.

Table 5: Proportion of farmers using the following component of CF techniques (%)

Technique	Cropping season				
	2004/5	2005/6	2006/7	2007/8	2008/9
Winter weeding	51	87	76	71	63
Application of mulch	40	75	69	70	56
Digging of basins	100	99	99	97	89
Application of manure	89	88	89	87	80
Application of basal fertilizer	71	75	74	66	38
Application of top dressing	94	92	99	88	70
Post planting timely weeding	94	98	99	96	85
Crop rotation	8	13	13	18	19

Source (Mazvimavi et al 2010)

Of the 416 farmers who were interviewed in 2009, 369 (89%) dug planting basins which is the most integral component of CA during the 2008/09 cropping season. This alludes that 11% of the farmers did not dig planting basins. Most farmers are conversant on when and how planting basins are dug. However, of the 160 interviewed recently in Zaka District for the purposes of comparison, 86% indicated that there is a risk of having the basin destroyed by wind especially dust storms are a frequent phenomenon), as well as heavy rain and animals that roam freely in unfenced plots. The % was almost to 89% found in Mazviamavi et al (2010) 2009 survey the

Chipinga case study. However, it must be noted that most farmers tend to start digging planting basins in the months of September to October (even up to November), as a result they consider digging of planting basins a laborious exercise yet they squeeze in the basin digging phase into a short space of time before the onset of the rains ZCATF, (2009)

4.4 Role played by NGOs in promoting CA in Zaka district.

From 2002 to 2005 there was food crisis in Zaka which invited immense concern of a plethora of humanitarian organizations. The situation was followed by food intervention from CARE international under Seasonal Targeted Assistance Program. CA was introduced as the only viable relief technology with the aims of promoting sustainable food production, ending poverty through Agriculture, improving household food security, increasing rural income levels and reducing land degradation.

4.4.1 provisioning of CA direct inputs

NGOs Provide farming direct inputs like seeds. According to Caritas 2016 review report on CA 1000 farmers in the district received 2 kg maize seeds open pollinated varieties (OPVS) and 10 lead farmers received 5 kilograms each and garden seeds to support nutritional gardens. Farmers preferred OPVs as they mature fast in a period of two months and they can resist dry spells. The researcher found out that lead farmers are there to demonstrate to other farmers' principles and concepts of CA from preparation to harvest directed by the CA calendar.

4.4.2 Trainings on CA concepts and new technologies

NGOs provide experimental trainings from land preparation to harvest using demonstration plots (demo plots), each ward have got its demo plot headed by the ward lead farmer and the help of the AGRITEX officers. Land preparation is the first step in conservation at which conservation

farmers dug planting basins according to the CA standards. According to Twomlow et al (2008) Planting basins are holes dug in a weed-free field into which a crop is planted. Basins are prepared in the dry season from July to October. The recommended standards of the basin are 15 cm × 15 cm × 15 cm, spaced at 75 cm × 60 cm. According to the C.A calendar provided above these operations are encouraged to be considered in between May and June.

Of interest sake to the majority of farmers was the concept of liquid manure making which is usually used on top dressing. Farmers were trained on how to make liquid manure. It is commonly applicable when plants run short of nitrogen and phosphorous, below are the stages of liquid manure making provided by a farmer during an interview.

Step 1; fill 50kg sack to $\frac{3}{4}$ with mixed dung and tie the sack,

Step 2; insert the sack in a $\frac{3}{4}$ filled drum of water

Step 3; stir the mixture and leave for at least 2-3 weeks

Step 4; dilute concentrate drum of liquid manure with 2 drums of water (1:2)

Step 5: apply 1 cup per each planting basin.

Field days are conducted before harvest. Every ward chooses the best field to host a field day. To this effect, the farmer who hosted the field day is given time to outline all the activities they undertook from preparation to harvest time. According to Caritas reports field days are primarily designed to celebrate good work carried by farmers, knowledge sharing through exchange visit, market linkages and to refresh farmers.

4.5 The Contributions of CA towards food security in Zaka district

CA aims to address the limiting factors of agricultural production in small holder environment by removing unsustainable parts that are tillage, residue removal and mono-cropping from the

conventional agriculture system through application of minimum soil disturbance, crop residue retention and crop rotation.

4.5.1 Boosting productive capacity of soils

Productive potential of soil rises because of enhanced interactions between the four interdependent variables of agricultural productivity: (i) hydrological: more water available; (ii) biotic: more organisms, organic matter and its transformation products; (iii) chemical: raised CEC gives better capture, release of inherent and applied nutrients: greater control and release of nutrients; (iv) physical: better characteristics of porosity for root growth, movement of water and root-respiration gases. Planting basins and application of manure helps to improve their lands in a long run. 60% of the farmers clearly outlined that before C.A they used to sell kraal manure to farmers who practiced irrigation farming under Fuve- Panganai Irrigation schemes. However, after the adoption of CA, farmers observed that instead of synthetic fertilizers, if organic manure is applied effectively the same plot of land can run for two farming seasons without any fertility amendments and yield at constant level Thus, CA reinstated soil fertility and soils productive capacity.

It was observed that CA can retain and mimic the soil's original desirable characteristics on land being first opened for agricultural. Doran and Zeiss (2000) alluded throughout the transformation to agricultural production CA can sustain the health of long-opened land which is already in good condition; and it can regenerate that in poor condition, CA can reverse the loss of organic matter, improve and maintain soil porosity and thus prolong the availability of plant-available soil water in times of drought.

4.5.2 Higher Stable Yields and Incomes from CA

The combination of features which raises productive potential of soil mentioned makes the soil a better environment than before for the development and growth of crops. Improvements in the soil's porosity had two major positive effects which are a greater proportion of the incident rainfall enters to the soil and the better distribution of pore-spaces of optimum sizes results in a greater proportion of the received water being held at plant available tensions. After the exposure to a rainless period, the plants can continue to grow towards harvest for longer compared to conventional farming. In addition, increased quantities of soil organic matter result in improved availability, and duration of their release into the soil water, of needed plant nutrients both those within the organic matter and those applied from the bag. Thus the availability of both water and plant nutrients is extended together. Under these conditions, plants have a better environment in which to express their genetic potentials, hence good yields experienced.

It can also reduce insect pest and disease incidence by biological means, raise agro-ecological diversity, favor biological nitrogen fixation, and result in both raised and better stabilized yields accompanied by lowered costs of production. From the study finding farmers experienced an average of at least 1333kgs of maize yields per **ha** which means an average of 333.25 kgs per 0.25**ha** (*demo plot size*). These yield statistics were in line with those provided by caritas in their 2017 annual review report for 2016.

Non adopters agreed that they experience at least an average of 850kgs per **ha** thus an average of at least 212.5kgs per 0.25**ha**. In line with the above stipulated maize yields the researcher found out that CA fields are more productive than conventional farms

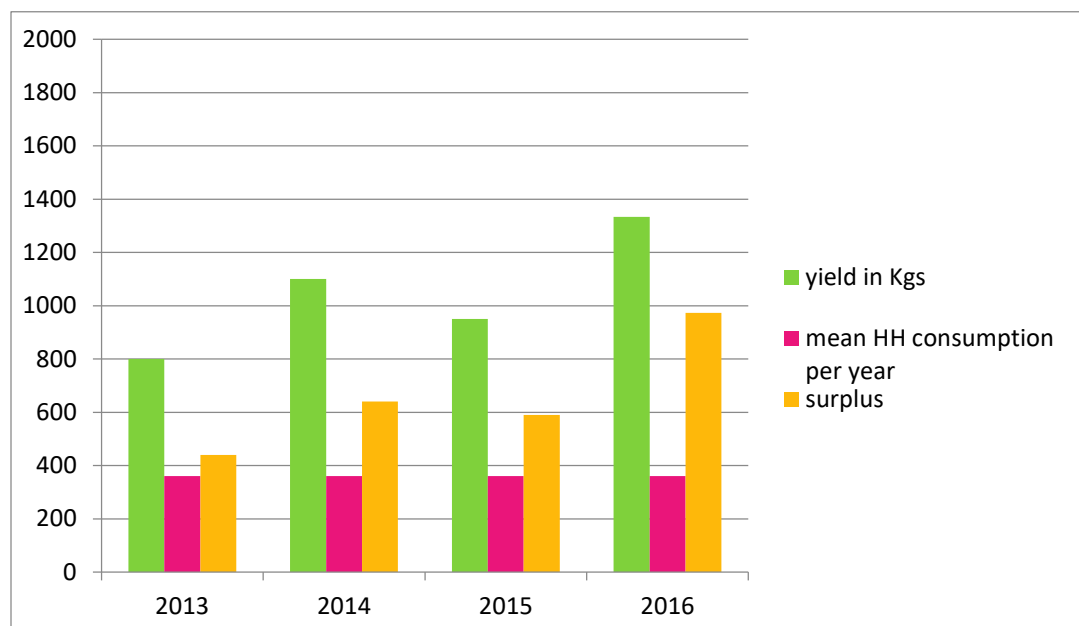


Fig 2: mean maize yields in kgs; mean household consumption per year basing on UN cereals sphere standards and surplus realized over several sites and seasons on sand-loamy soils in Zaka communal lands under CA basins and treatments

Source: primary data

Basing CA studies on sand-loamy soils in Zaka district, by CIMMYT have shown that the yield benefits from CA gradually increase in the long run. The yield benefits witnessed by farmers on CA demonstration plots increased the number of experimenters. The researcher observed that CA increases the rate of food availability particularly on cereals given that CA farmers realize income they use to buy other food stuffs apart from cereals.

4.5.3 Climate Change adaptation and Less Vulnerability

Less susceptibility to effects of drought, less erosion, lower soil temperatures, represents a managed adaptation to climate-change's effects for example, more intense rainstorms, increased

daily ranges of temperatures, and more severe periods of drought. Good mulch cover provides ‘buffering’ of temperatures at soil surface which otherwise are capable of harming plant tissue. Decomposed organic matter used as fertilizer proved to mend the soil structure therefore increasing its water holding capacity. Mulch is a material spread on top of the soil to conserve moisture. Mulch made from organic materials such grass and tree leaves break down into compost, further increasing the soil’s ability to retain water. Compost and mulch help Vegetables gardeners especially Cheziya garden in Ward 5 Zaka district and field farmers to retain more water in the soil during the dry season.

Observations in Zaka district indicate that maize crops under CA had higher germination rates and better resilience to moisture stress (Ministry of Agriculture, Mechanization and Irrigation Development, 2010a, b). Crops under CA were observed to grow more continuously towards maturity without major drought stress as compared to crops under conventional tillage. In addition, the period in which available nutrients can be taken up by plants is extended due to higher available soil moisture. Murongwe et al (2011) argued that untilled soils also act as carbon sinks by sequestering amounts of carbon that would otherwise be released to the atmosphere and contribute to temperature increases. Therefore, CA is a mechanism to reduce the impact of climate change on agricultural systems. Thus one can derive the basis to propound that by mitigating and minimizing the negative effects of climate change CA contributes towards food security.

4.5.4 Cost effectiveness and efficiency

80% of the respondents argued that CA is cost effective considering cost benefit analysis because it allows farmers without draught power to farm on time without hiring draft power. Hove and Twomlow (2006) argued that majority of smallholder farmers in Southern Africa struggle to cultivate their fields in timely manner due to lack of draught power such as donkeys and cattle.

Respondents argued that they only need livestock to produce manure which they put at the bottom of planting basins also when they make top dressing liquid manure. Therefore, this improves food security since they manage to grow their crops in time. Furthermore 80% of the respondents outlined that, CA helped them since it advocated for organic manure a cheap natural inputs accessed by the majority. In this case they were trained to make both underground and open compost as well as liquid manure for top dressing. To this end CA involves less input of energy per unit area, per unit output, thereby lowers farming cost and increasing the profit margin by diversifying and optimizing farm productivity.

4.5.5 Income realization from the sale of CA produces

Farmers have highlighted that initially they practiced CA for subsistence but recently it was commercialized especially among garden farmers. CA gardens are like killing two birds with one stone. Gardeners pointed out that from gardens they manage to get their nutritional support at the same time gain income from the sale of surplus produce.

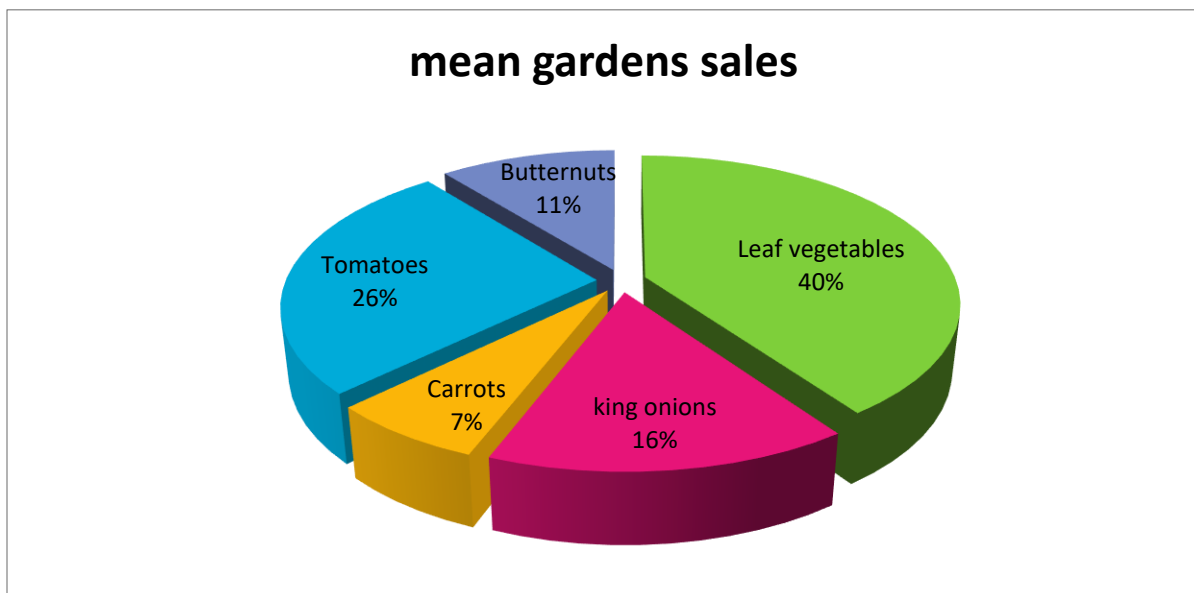


Fig 3 | the pie chart illustrates income realized from the sale of various garden products. An average of \$300 is realized per month per garden given that there are operating at a full scale. Vegetable sales constitute 40% of the overall income which is \$120, tomatoes fetch 26% of the total income which is \$78 followed by king onions holding 16% of the total income which translate to \$48. Butternuts are seasonal normally their yield get affected by pests and diseases nevertheless they constitute 11% of the market share which translate to \$33. Then lastly carrots hold the lowest percentage of the total income thus they contribute \$21. Gardeners have highlighted that CA gardens are their source of livelihood. From the income realized from gardens farmers manage to acquire other social amenities like health facilities, paying school fees above all buying other food stuffs they cannot produce on their own (Caritas public health report, 2017)

4.5.6 Reduced Greenhouse Gas Emissions

No-till reduces unnecessary rapid oxidation of organic matter to CO₂ which is induced by tillage. The addition of mulch as a mechanism of saving crop residues resulted in the reversal from net loss to net gain of carbon in the soil, and the initiation of long-term processes of carbon sequestration. According to Testa et al. (1992), soil carbon content increased by 47% in the maize lablab system, and by 116 % in the maize-castor bean system, compared to the fallow maize cropping system which was taken as a reference. In systems where nitrogen was applied as a fertilizer, the carbon contents increased even more.

Baker et al. (1996) found that crop rotation systems in CA accumulated about 11 t/ha of carbon in the topsoil (0-17.5 cm) after nine years. Under tillage agriculture and with monoculture systems the carbon liberation into the atmosphere was about 1.8 t/ha per year of CO₂ (FAO, 2001a). CA systems can also help reduce the emissions for other relevant greenhouse gases, such as methane and nitrous oxides, if combined with other complementary techniques. Both methane and nitrous

oxide emissions result from poorly aerated soils. Also CA reduced use of tractors and other powered farm equipment results in lesser emissions of exhaust gases. Therefore, it is argued that by reducing the amount of greenhouse gases emission CA ensures food security by reducing the chances of climate change. According to the Kyoto -protocol high emissions of greenhouse gases are responsible for climate change.

4.5.7Market linkages

A market- oriented food system, if available, offers additional income generating opportunities that allow small procedures to compete with quality while encouraging local food supply, Mgbenka and Mbah (2016) CA farmers in Zaka district lacked advertising skills before C.A projects. They suffered market problems but now they take advantage of farmer groups such as Hndeitose farmers association in Zaka to advertise their farm produce and other commodities. NGOs like Caritas arrange and host district agricultural shows where farmers showcase and sale their products of different categories. During those shows they share knowledge on how they produce their products and challenges they face

4.5.8Mitigating land degradation

CA promotes agriculture without land externalization a process of clearing more land that is under natural vegetation. In conventional agriculture systems, soil losses of up to 50t/ha/year through sheet erosion and water losses of the order of 30% of seasonal rainfall have been estimated by (Elwell, 1985). In mulch ripped CA systems, soil losses of below 5t/ha/year were recorded (Nyagumbo, 2002). C.A systems resulted in soil aggregate stability which in turn led to the soils able to yield much.

Soil aggregates are groups of soil particles that are accumulated as an outcome of soil development. The ability of soil aggregates to resist disintegration from forces associated with tillage, water or wind is referred to as aggregate stability, and an increase in the aggregate stability serves as a sign of increase in soil quality and soil health. A general increase in soil aggregate stability has been observed in CA systems over several years in similar trials by researchers from CIMMYT, Regional trials have shown the positive evidence of CA on water productivity (Thierfelder and Wall,2009); (Thierfelder and Wall ,2010a). Higher water infiltration rates have been recorded in CA systems as compared to conventional systems. Thus one can be persuaded to argue that C.A is the best available answer to mitigate land degradation as a result restore and boost the quality and health of soils through gained aggregate stability hence, contributing towards food security as high crop productivity are usually experienced on quality health soils.

4.6 Implementation detriments of CA in Zaka district

This sub section discusses challenges encountered in CA production. There are a number of challenges which are detrimental to the positive contributions of CA towards food security. These challenges are categorized into economic, social and political challenges. Generally, CA is labor intensive, this is the major challenge faced by C.A farmers, and they lacked CA equipment so they rely on hand hoe for basin preparation and weeding. However, there are other factors which compliment labor intensity which threatens CA success in Zaka.

4.6.1 Challenges in Implementation of CA in Zaka

Labor shortage

According to Todaro (1982) in economics of development there are four modes of production which are land, labor, capital and education. 70% of farmers adopters and non –adopters agreed

that CA is labor intensive particularly during land preparation and weeding. CA advocates for minimum or zero tillage and smallholder farmers in Zaka district largely depend on hand hoe from land preparation to weeding whilst farmers would want to focus on other off farm activities like gardening, pottery, weaving and basketry. This was supported by www.wcca.org (2011) which argues that CA practice requires farmers to keep their plots weed free throughout the season. If any weeds are to appear weeding should commence immediately. This activity therefore is labor some as it became difficult for farmers to provide weeding thrice due to labor shortages as some of the household members particularly men have other off- farm commitments. Labor demands proved to be the most challenging factor hindering adoption of CA among smallholder farmers.

Input shortage

Lack of access to inputs such as seeds, fertilizers and equipment among smallholder farmers provides a major challenge to the full practice and success of CA. Primarily farmers enjoyed free input access from NGOs. This element is fundamental because increased adoption rate was registered in areas where there was strong NGO support. Free input scheme had also a direct impact on CA plot size. These input handouts are usually just enough for small CA plots. There is evidence that access to inputs influences the area allocated to CA. Farmers tend to expand the area under CA on the basis of input availability from NGOs. The initial message from NGOs was to target a CA area of 0.25 hectares (Twomlow et al, 2008). Farmers have started to allocate closer to 0.5 hectares to CA. Later on NGOs withdrew their support. In Zaka province many NGOs were banned during the 2008 as they were suspected by the ruling part to be fueling regime change agenda. Care international which was the major player in supporting CA was also banned leaving farmers with nowhere to access inputs. As a result farmers started to reduce the size of CA plots

and some resorted back to conventional due to lack of capacity to acquire inputs from alternative sources Thus, the withdrawal of NGOs support resulted in shortage of CA inputs in Zaka district

Lack of adequate Markets

Though there is increase in yields, the challenge emerged pertaining where and how to sale surplus. CA production in Zaka district is characterized by inadequate markets to absorb surplus produce. In the past years' farmers highly depended on GMB which was a potential market of grains, but now GMB is poorly performing, hence lack of markets. Farmers in Zaka are not developing because they lack access to markets which are a crucial element for uplifting economies of scale. Rural farmers lack marketing skills such as advertisement and value addition so they largely depend on black market which usually underpays their farm produce. Prior to lack of markets farmers fail to return the money they used to buy inputs.

Political bias

NGOs are the chief promoters of CA in Zimbabwe, but in 2007 before elections the program was vulnerable to political intervention since the ruling party (ZANU PF) condemned NGOs on the assumption that, there were pushing regime change agenda. To this effect a number of NGOs were banned particularly in Zaka district only Faith based Organizations were exempted. This then compromised the spread and support of CA knowledge to farmers hence project duration runs out before the project meet its targeted objectives and goals. For example, in Zaka CARE officers were violently disbursed by local war veterans. Therefore, CA is not immune to political upheaval, therefore CA suffered political instability since its drivers NGOs are the common enemy of ruling party.

Identity confusion

It was noted that a number of farmers have identity confusion. They want to be identified as CA farmers for other benefits whilst they mix farming types. For example, almost 10 % of farmers were reviewed to mix CA components with conventional elements. This was commonly observed in times of crop pest and diseases. In CA system if it occurs that the field is attacked by pest or diseases farmers are encouraged to spray natural or organic herbicides which are environmental friendly for sustainable land use. However, from the interviews carried out almost 20% of the farmers indicated that in 2016 their maize crop where affected by stock bora worm and they used artificial pesticides to get rid of the worm. Also some run manure shortage during top dressing they resorted to the use of synthetic fertilizers donated by the government under the command agriculture system. In a case of crop failure CA found to be blamed forgetting the reality that mixed methods were applied. Therefore, identity confusion among farmers stands to the detriment of CA in Zaka district.

Limited extension support

CA lacked extension support Nkala etal (2011) in some instances where extension services are provided, extension workers conceptualize their involvement in the CA projects as extra work for which they should be remunerated separately. Since CA is a knowledge intensive technology, it would be difficult to successfully promote this technology without the help of well-trained and experienced extension workers. They only offer support during the period when NGO operate in that particular area, because they will be enjoying more remuneration. Therefore, to this effect they refused to support the program without other incentives, a condition which compromise proper dissemination of CA knowledge into communities without NGOs. In Zaka Caritas and care

international give \$10 allowances per day to AGRITEX officers as payment for their services. Many of them if invited without allowances they do not attend. This is the main challenge faced by CA.

Mkomwa (n.d) argued that in Africa, investment in agricultural extension services, a critical component to the success of food output and has been described as low and lacking coordination. It is reported that the ratio of public extension workers to the farmers is 1:3000 in developing countries while the ratio is 1:400 in the rest of the countries (<http://www.aiaee.org>, 2011). One of the contributing factors is the absence of a legal and policy framework for providing the extension services, including budgetary allocation. Thus lack of adequate extension support hinder full scale production of CA hence undermining the probability of CA to bring about food security. STOVE

Lack of Mulch

All smallholder farmer experienced mulch problem as a challenge in practicing all three principles of CA. Crop residue such as maize stove is used to feed live stock during dry season particularly in winter when pastures are dried up. Grass is a problem and it is not enough for their live stocks and they cannot use it as mulch material and in most cases is highly used as roofing material. In some cases, they used crop residue of millet and rapoko which is not ideal for livestock feeding but it brings about termites. It can be noted that crop residue retention attracts termites to permanently live in the field and attack next crops this result in poor germination and poor crop development. Hence mulch is a real problem in Zaka of which farmers decide to implement only two principles of CA and leave their fields without soil cover which therefore expose crops to sun rays and poor moisture retention leading to reduced yields.

Chapter summary

The chapter presented, analyzed and discussed findings of the contributions of CA towards food security in Zaka district. The chapter also examined factors that influence the adoption of CA in Zaka district. Adoption trends of CA in the district were also reviewed using a 6 year comparison. Detrimental factors that hinder CA were discussed in their various dimensions that are social, economic, political, environmental and technical factors. Labor intensity proved to be the chief challenge to explain why CA adoption and success is still limited in Zaka. However, it is further exacerbated with climate change, lack of market linkages, lack of CA equipment and unavailability of mulching material.

CHAPTER FIVE

CONCLUSIONS AND RECOMENDATIONS

5.0 Introduction

The aim of this chapter is to sum up the purpose of this study and its findings. Also, a proposal of recommendations and policy implications will be made which will be followed by an outline of areas that may need further study. The recommendations to be discussed are alternative strategies that can be taken into account to ensure the improvement of the contributions of CA towards food security in Zaka district.

5.1 summary.

The research assessed the contributions of CA towards food security in Zaka District. It was observed that Zaka district is prone to food insecurity due to weather vagaries experienced yoked with poor farming methods practiced the District thus, led to the introduction of CA as a technological option to boost crop productivity in the district. Specific objectives of the research were to assess the adoption trends of CA in Zaka, to identify household determinants factors which significantly motivate the adoption of CA in Zaka district, to assess major success contributions of CA towards food security and to assess CA implementation detriments in the district. The research made use of 204 farmers across the district both CA adopters and non -adopters for the purposes of comparison. Stratified random sampling was used to come up with a sample of 204 respondents from the four strata. In the district CA is practiced in both fields and gardens. Findings From the study showed that CA adoption is still low as shown by 7-year comparison of adoption trends presented in chapter 4. Different interrelated variables were found to influence CA adoption per household level. Variables include HH size, number of livestock per HH, education level of the HH head, frequency of extension visits, gender, and farm size among others. CA ensures all

four aspects of food security that are; food availability, food access, food utilization and stability. CA contributions are dynamic. It has economic, social, political and environmental contributions towards food security. CA increased yields by 50 to 100% thus making food available. It can be noted that CA came with nutritional support in Zaka district. CA nutritional gardens are supplementing household nutrition status thereby farmers utilizing all the necessary food nutrients for human growth. Due to CA practices in the District the cases of malnutrition and under nutrition decreased and other hunger related diseases like kwashiorkor. Farmers reviewed that CA is boosting their household income which they use to purchase other food stuffs they cannot grow on their own. Farmers also use the incomes for ISALS. Socially CA is reckoned for improving social networks of households in Zaka through district agricultural shows and field days where farmers met and share their CA experience from field preparation, harvest and grain storage. Also they share how to prepare food especially traditional food like Maheu, rapoko-sadza among others. Findings indicated that CA is the remedy for the attainment of food security in the district; however, the initiative is facing a plethora of implementation challenges which are hindering the effectiveness of the intervention in as far as food security is concerned.

5.2 Conclusion

From immemorial in 2004 CA adoption trends were not constant but increased yearly up to 2007. A decrease was noted in 2008 and the major underlying cause was political- economic crisis experienced in the country in 2008. Due to that crisis many NGOs supporting CA were banned and some withdrew their support. It was noted that from 2008 up to current CA adoption trends reached constant levels though the adoption rate is still low. HH size and plot size were found to be the major contributory variables for the adoption of CA the reason being CA is labor intensive therefore, since many farmers lack CA modern equipment and rely on hand hole for basin

preparation and weeding much labor proved to be needed throughout the farming season. HH with a large membership proved to experience positive favorable outcomes in their CA fields and gardens than small households. CA improved yields by 50 to 100%. Small plots harvest more than expected. 0,25ha expected to produce 250 kilograms of maize produce even more up to 350-400 kilograms thus increasing food availability in the district. Labor constraints, inadequate policy framework and lack of coordination among all CA to improve CA practice in the district are the major detrimental factors for CA implementation.

5.3 Recommendations.

5.3.1 Mechanization of CA

Future CA programs should explore innovative ways that address the high labor requirements associated with the technology. Thus, mechanizing some of the operations such as basin preparation and weed control. Labor saving technologies such as introducing other CA implements other such as use of herbicides should be promoted, also the use of jab planters that are also labor saving can be alternatives for vulnerable farmers (Bishop-Sambrook et al.2004). On the other hand, for resource endowed farmers, the use of rippers and direct seeding equipment could be good options particularly if the linkages to both input and output markets are available.

5.3.2 Institutional Support

Extension support offers a significant link between the technology and farmers and ultimately sustains CA production. However, this role has so far been limited due to resource constraints in the national extension service (AGRITEX) due to economic crunch in the country. It is important to strengthen the functional role of AGRITEX to implement and promote improved cropping technologies to farmers. NGO supports of CA are not permanent; therefore, this practice can only

be sustained through involvement of the national extension service. Institutionalization of the technology promotions through AGRITEX will significantly contribute to sustained CA production.

5.3.3 Level of NGO Support

Sustainable CA promotions should move away from NGO-related input support (dependency syndrome) and encourage market-led interventions such as input credit facilities especially from local micro finance institution and through seed and fertilizer companies and other public institutions, such as the Grain Marketing Board. Solely because farmers associated with access to free inputs are therefore, predisposed to stop practicing CA when input support is introverted.

5.3.4 Training of extension officers

The training of government and other extension staff, which has been going on in Zimbabwe, should be a continuous activity and should encompass new technologies.

5.3.5 Inclusion of resource endowed farmers.

The promotion of CA should include resource endowed households. Thus follows the thinking that resource endorsed farmers are capable of practicing CA at a macro scale due to their capacity to purchase the much recommended mechanized CA equipment. Therefore, they will be driving towards food security in the district due to their capability to produce at a larger scale, hence food availability and equitable food distribution.

5.3.6 Providing Knowledge, Education and Learning Services

CA encompasses a fundamental change in the way people think about agricultural production and how it is related to environmental stewardship and nature. There are three implications of this.

First, we need to think differently about how cognitive knowledge is spread to farm families, of all farm sizes, and to public at large. One necessary change will be to inculcate schoolchildren and then right up through graduate and postgraduate education. This will ensure the need to go beyond tillage agriculture and to understand the importance of CA systems in all settings for sustaining the production of crops and water from landscapes, and for protecting the environment and biodiversity. Doing this will ensure that CA principles become the accepted norm for agriculture and environmental stewardship, whatever the scale of farming.

5.3.7 Accessibility and Affordability of Required Inputs and Equipment

There is need for government to make CA inputs affordable and accessible to all farmers at all levels thus both commercial farmers and smallholder farmers. There are costs involved in making the transition from tillage-based agriculture to CA. The farming patterns which preceded a farmer's decision to switch production techniques may not have produced enough saved resources to allow him or her to accept all the potential risks associated with the change-over.

5.3.8 The Need to Sensitize Policy-makers and Institutional Leaders

It is important that policy makers fully understand the implication of the CA system. This makes it easier for them to justify supportive policies and have desirability of backing the initiatives which at the end are beneficial not only for the farming community but for everyone. On the other hand it is vital for policy makers to think along long term developments and in integrated approaches, even across sectors and ministries.

5.3.9 Targeting bigger households

Since CA practices are labor intensive, it is sensible for CA promoters to target bigger households who can provide the labor requirement to work in the fields. This is because rural households can

hardly hire labor because of financial constraints and thus they rely on family labor, so if a household has got few members it may prove very difficult for them to practice all CA components

5.3.10 Sound coordination of stakeholders

There is need for sound coordination for all stakeholders in the economy to work together in supporting incremental adoption and practice of CA rather than having antagonistic and biased interests. If mutual coordination is achieved between such stakeholders like NGOs, FAO, AGRITEX, department of mechanization and irrigation (and others related to agriculture) to work towards one goal of enhancing CA. CA would achieve incremental rewards towards food security in the District.

5.4 Suggestions for further research

The research covers only Zaka district which is only one district out of several districts in Masvingo province. Albeit other studies may have been done elsewhere more research need to be carried out in different districts so that the contributions of CA towards food security can comprehensively be determined. Also further research is needed to track whether resource endowed farmers practice CA practices or not in Zaka District.

5.5 chapter summary

The chapter summarized the contents of the entire research. The major objective, specific objective and research findings. Finally recommendations were made to CA stakeholders for effective implementation of CA practices and suggestions for further research were also given.

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QUESTIONNAIRE

My name is Nyasha Gotoza and I am a student at midlands state university pursuing Bachelors of Arts honors degree in development studies. I am doing a research on the **CONTRIBUTIONS OF CONSERVATION AGRICULTURE TOWARDS FOOD SECURITY IN ZAKA DISTRICT**. The information obtained is only for academic purposes and your responses will remain confidential. Please note that there is no any material benefit accrued as a result of participating in this research now or in future. Should you wish to decline to be interviewed, you are at liberty of doing so without hesitation.

Household Questionnaire

Ward_____ Adopter_____ Non adopter_____

Village_____ Date of Interview_____

A. HOUSEHOLD CHARACTERISTICS

1. What is the gender of the household head? [1]___Male [2]___Female
2. What is the age of the household head?_____ years
3. Fill in the table below about household composition:

Household member	sex	Age	Highest Level of education	Occupation

4. How many of the above assist with farm labor?

5. Does the household have permanent employees who assist with farm labor?
[1]..... Yes [2].....No
6. If the answer above is yes what is the number of these employees
7. Do you sometimes hire in labor to supplement farm labor? [1].....Yes [2]..... No
8. If yes on (7). How many times on average do you hire labor in one farming season?
9. How much do u spend on hired labor on average per season?

B Household assets, income and wealth

10. Livestock endowments :

Livestock	cattle	Goats	Sheep	chicken	Donkeys	Pigs	Other (specify)
Number							

11. is the household head employed off farm [1].....Yes [2].....No
12. If the answer is yes on (11) how much income is earned per month?
13. Are there some household members employed off farm? [1].....Yes [2].....No
14. If yes how many are those members?

C CROP PRODUCTION

15. What is the size of your total farm land in hectares.....
16. What is the size of your total farm land under crop production?
17. Is your farm land producing enough yield for subsistence without the use of chemical fertilizers [1] Yes_____ [2]_____No
18. Do u apply chemical fertilizers on your crop and garden production [1]..... yes[2].....No
19. What is the Average cost of inputs per season per hectare under

- I. Conventional agriculture
- II. Conservation agriculture

20. How many years have you been in farming as an adult?.....years

21. What is own understanding of conservation agriculture?

.....

.....

.....

.....

.....

22. Which conservation agriculture do you specifically practice?

- (I)Crop rotation
- (ii) Zero tillage
- (iii) Mulching
- (iv) Others
- (v). All of the above.

23. Fill in the table below about the hectares under conventional and conservation agriculture and respective yields per hectare

Crop	Conservation Agriculture								Conventional Agriculture							
	Hectare				Yield/ hectare				Hectare				Yield/ hectare			
	04/05	05/06	07/08	09/10	04/05	06/07	08/09	09/10	04/05	05/06	07/08	09/10	04/05	06/07	08/09	09/10
Maize																
Sorghum																
millet																
groundnuts																
Other(s) specify																

24. For how long have u been practicing CA (**specify year**)

25. Have you ever stopped Practicing CA? [1]Yes..... [No]

26. If yes when did you stop practicing CA and when did you resume?

b) Why did you stopped practicing CA during those years?

27. What do u think are the merits of CA to Conventional Agriculture?

I.

II.

.....

III.

.....

IV.

.....

V.

28. Do you find Conservation agriculture challenging as compared to conventional agriculture

[1].....Yes [2].....No

29. What are the major problems/ challenges you face in practicing CA as compared to

Conventional agriculture?

I.

.....

II.

.....

III.

.....

IV.

V.

30. Fill in the table below for CA gardens

Crop	Farm consumption (Kg) by season			Sales (kg) by season		
	08/09	09/10	10/11	08/09	09/10	10/11
King Onions						
Tomatoes						
Leaf vegetables						
Butternuts						
Carrots						

D ACCESS TO INFORMATION AND SUPPORT

31. Who initiated you into practicing conservation agriculture? (i) NGO(s) (ii) neighbors
 (iii) extension official

32. Did you receive any agricultural support during 2008 and 2015 season [1].....Yes
 [2].....[No]

33. What type of agricultural support? (i) input credit (ii) contract growing

34. Who provided the agricultural support (i) local bank (ii) NGOs (iii) micro –finance
 institutions (iv) government institutions

35. What is your major source of agricultural services? (i) AGRITEX (ii) NGOs (iii)
 Contracting company (iv) other specify

36. In the last three years how many times did extension officers visit you for the purpose of helping with information on farming?.....times

37. Are you a member of any organization [1].....Yes [2]No