

**Analysis of conservation agriculture adoption. A case of Chiwundura communal area, Zimbabwe.**



**A research project submitted to Van Hall Larenstein University of Applied Sciences in partial fulfilment of the requirements for the degree of Master in Management of Development, specialisation in Rural Development and Food Security.**

**By Innocent Dzuke**

**Van Hall Larenstein University of Applied Sciences**

**The Netherlands**



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### **Dedication.**

This work is dedicated to my wife Karen Shiri Dzuke without whose caring support it would not have been possible, and my loving mother Shungu Dorcas Dzuke who passed on a love of reading and respect for education.

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### **Abstract.**

Conservation agriculture is a way of farming that conserves soil and water, resulting in improved crop production. It has been promoted in Zimbabwe to address the climatic variations affecting small holder farmers who do not have access to irrigation facilities to supplement water in times of drought. Despite the promotion, adoption has been generally low in the small holder sector and farmers in Chiwundura communal area are no exception. A case study was conducted in 3 communal wards of Chiwundura communal area to find out the suitability of conservation agriculture practices promoted in the area. The socio economic, technical attributes, institutional and cultural factors as determinants of adoption were assessed to 24 farmers, divided into 3 categories; farmers practicing conservation agriculture, farmers who stopped practicing conservation agriculture and farmers who never practiced conservation agriculture by getting insights into their reasons for adopting/not adopting conservation agriculture practises promoted in the area. Chiwundura communal area was selected because it is where conservation agriculture has been promoted owing to high temperatures and low rainfall. Selected farmers adopting conservation agriculture had at least 3 years' experience of adopting conservation agriculture.

Semi structured interviews were conducted to farmers and extension workers as key informants. The findings revealed that the most common conservation agriculture practise promoted is the planting basin, which however, suits many farmers as it is a cheap practise. Although farmers revealed that there was improved crop yield associated with the basins, challenges such as high labour requirements were noted. Female headed households had competing labour demands with household chores compared to male headed households. This affected adoption and expansion of the area under conservation agriculture. Migration of household members to neighbouring countries, illness and young children who cannot go to the field were among the reasons for shortage of labour in the households. There was no link between adoption of conservation agriculture and education as all farmers in all the categories had an equal level of education and an understanding of planting basins. There was no big difference in the land size for all the categories of farmers revealing that land size does not influence adoption, but however for farmers practicing conservation agriculture, not all land area was put under conservation agriculture. Because farmers were engaged in on farm activities as a source of income, there were no competing labour demands with off farm activities. It was shown that farmers do not practice crop rotation with a leguminous crop because of household food requirements making crop rotation not fitting into the farming system. Most households owned cattle, therefore an opportunity for farmers to use draught powered conservation agriculture implements. On the other hand, livestock destroys crop residues which act as mulch therefore limiting adoption. Mulching and crop rotation are therefore not fully practiced by farmers. The high costs of inputs remains a bottleneck to farmers. Given that farmers adopt conservation agriculture without input support and that conservation agriculture is allowed in the community enhances the possibilities of translating conservation agriculture successfully in Chiwundura communal area.

Therefore, if food insecurity issues are to be resolved in Chiwundura communal area, it is recommended that AGRITEX to encourage farmer groups and have a bargaining power so as to negotiate for input prices, such as seed, fertilisers and conservation agriculture implements

that reduce labour requirements. Farmer groups will also enable farmers to spread work especially for the female headed households, access to other services such as training on conservation agriculture and keep abreast to development on conservation agriculture. AGRITEX to use a participatory approach with farmers to identify and develop solutions to their problems in conservation agriculture. AGRITEX to provide extension workers with more information on mechanised conservation agriculture systems through training; that will enable extension workers to avail a variety of conservation agriculture options and allow farmers the final say on the option to implement depending on the socio economic conditions of farmers.

### **Acronyms.**

ART	Agricultural Research Trust
AGRITEX	Agricultural Technical and Extension Services
FAO	Food and Agriculture Organisation
CGIAR	Consultative Group on International Agriculture Research
ESS	Environment Software and Services
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agriculture Development
MAMID	Ministry of Agriculture, Mechanisation and Irrigation Development
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
REC	Regional Economic Community
UN	United Nations
USDA	United States Department of Agriculture
WFP	World Food Programme
ZCATF	Zimbabwe Conservation Agriculture Task Force

## Chapter 1: Introduction.

### 1.1 Zimbabwe context.

Zimbabwe is a landlocked country in the Southern Africa region with an area of over 390 000 square kilometres (FAO, 1997). Climatic conditions are largely tropical with one rainy season, between November and March. Rainfall reliability decreases from north to south and also from east to west. Agriculture in Zimbabwe follows the country's sub-Sahara climatic pattern, which influences crop and livestock production. As shown by table 1, it is divided into five distinct natural regions on the basis of rainfall patterns, with only 37 percent of the country receiving more than the 700mm annual average rainfall that is considered necessary for semi-intensive farming.

Table 1: Agro ecological zones of Zimbabwe and recommended farming systems.

Natural Region	Area (km <sup>2</sup> )	Rainfall (mm yr <sup>-1</sup> )	Farming system
I	7 000	>1 000	Specialized and diversified farming
II	58 600	750 – 1 000	Intensive farming
III	72 900	650 - 800	Semi-intensive farming
IV	147 800	450 - 650	Semi-extensive farming
V	104 400	<450	Extensive farming

Source: (USDA, 2004)

### 1.2 Agricultural sector.

Zimbabwe has a diversified agriculture sector with 11 to 20 percent of the country's annual gross domestic product being generated by agriculture as well as 45 percent of exports. The agriculture sector is composed of large scale commercial farming and small scale farming, with the later occupying more land area but located in regions where land is less fertile with more unreliable rainfall (Marongwe, Kwazira, Jenrich, Thierfelder, Kassam and Fredrich, 2011). The agricultural sector is declining rapidly as a result of rainfall variability and socio economic instability. Despite the decline in the performance, the agriculture sector continues to play an important role in the country's economy and social development.

Yield levels and productivity of most smallholder farmers in Sub Sahara Africa are generally low and have a declining trend in the region (Thierfelder and Wall, 2010). As a result, food security and income for most small holder farmers have declined significantly (ZCATC, 2009), yet most small scale farmers depend entirely or largely on their own cereal production. Poor soils and unreliable rainfall are the major constraints to food production and sustainability of smallholder agriculture in Zimbabwe. These challenges are further compounded by low incomes, labour and land constraints faced by the majority of small holder farmers (Sanginga and Woomeer, 2009).

Conservation agriculture as defined by Twomlow et al. (2008) encompasses activities such as minimum tillage and zero tillage, tractor powered and manual methods, integrated pest management, integrated soil and water management and includes conservation farming. It is being promoted as a potential solution to the production problems faced by smallholder farming families in Sub-Saharan Africa (Haggblade and Tembo 2003a, Hobbs 2007). It is being promoted in Zimbabwe as a sustainable agricultural technology that increases productivity and at the same time preserves and conserves the environment (IIR and ACT, 2005). Conservation agriculture has been in the last few years widely promoted in Zimbabwe by various stakeholders, including governments, donors/Non-governmental organizations and private sector. The recognition of the positive impacts of conservation agriculture on crop productivity, generated in other parts of the world led to intense promotion by many NGOs in 2003. The positive impacts include, reduction in soil erosion, prevention the level of soil fertility going down and conserving water (Breton, 2012). The need for coordination of conservation agriculture activities emerged during these early stages which resulted in the formation of the Zimbabwe Conservation Agriculture Task Force (ZCATF) in 2003 at the request of donor to set up technical guidelines for implementing conservation agriculture (Marongwe et al., 2011).

The Conservation Agriculture Task Force comprises of NGOs, CGIAR centers, Universities, Ministry of Agriculture (AGRITEX) and FAO. The taskforce implements, monitors and disseminates information on conservation agriculture. Over the years, both farmers and agencies implementing conservation agriculture have experienced both successes and challenges. The successes have resulted in the number of farmers practicing conservation agriculture increasing dramatically, from a few thousand thousands during the initial years, to over 300 000 in the 2010-2011 agricultural season. Practicing farmers have generally attained higher yield levels. These have been attributed to early planting, increased efficiency of fertilizer use and crop resilience to dry spells, coupled with better crop management practiced by conservation agriculture farmers (Breton, 2012). In recent years, there has been a rapid increase in the number of farmers practicing conservation agriculture technologies involving planting basins. The planting basins were mainly promoted mainly to address draught power shortages in the communal sectors. Currently, ZCATF is promoting other conservation agriculture options to the small holder farmers like the use of rippers, direct seeders and jab planters to intensify area under conservation agriculture.

### **1.2.1 Study area farming system.**

Chiwundura communal area is located in Gweru district in the Midlands province of Zimbabwe. It has a population of 62 765, out of which there are 30 825 (49 percent) females and 31 940 (51 percent) men. It has a total of 14 898 households, and an average of 4 people per households. It has 8 wards out of which 5 wards have a higher proportion of females compared to men. These wards are ward 5,10,11,12 and 17. Wards 13 and 16 have parity in population distribution across the genders. Wards 9 and 16 have a higher male population and this is most pronounced in the latter ward where the difference is significantly higher. The major economic activity is farming (Parliament Research Department, 2011). Chiwundura is characterised by dry conditions and high temperatures. Maize and other small grains like sorghum, pearl millet and finger millet are the major crops grown.

In communal area, land is communally owned and allocated to families for arable farming and settlement (ESS, 2002). An individual farmer is allocated arable fields and granted rights to graze his animals in non-cropped areas (Hagmann, 1999). Land allocation in the communal lands remains a source of conflict, with local government, political parties and tribal authorities, all having a varying degree of control. The farming system of Chiwundura communal area is such that small holder farmers use extremely limited inputs, with a very small minority of farmers applying chemical fertilizer, and usually only for maize. Communal farming is characterized by low and inadequate soil, land and crop management techniques. In many cases land preparation is of a low standard, planting is often delayed and crops are not well managed (ZCATF, 2009). Tillage is performed with oxen and weeding is done by hand. The average land per household ranges for about 2 hectares to approximately 5 hectares (Phillips, et al, 2002). Most small holder farmers could be considered purely subsistence farmers as they grow mainly cereal crops for food consumption. They are mainly engaged in on farm activities and women participate in vegetable production or beer brewing from sorghum or finger millet to supplement household income. Additionally, food crops are often sold after harvest when cash is in short supply. This often leads to the household running out of stored grains and the household has to purchase food before the grain from following year is harvested.

### **1.3 Problem definition.**

Zimbabwe like many other countries in Sub Sahara Africa faces challenges to food security attainment arising from low productivity and production. Food security prospects in Zimbabwe for 2012/2013 are the worse in the last three years. Aggregate cereal production for 2011/2012 season was 33 percent lower than in 2010/2011 (WFP, 2012). This is a worrying trend given the fact that cereal production is decreasing yet cereals are a staple food in Zimbabwe as shown by figure 1. Close to half of Zimbabwe's population-about 6 million people are currently food and nutrition insecure (UN, 2009). The key reasons for this state of affairs are the continuing low agricultural productivity, deteriorating soil fertility, dysfunctional input and output markets and the unfavorable macroeconomic environment (Jama and Pizzaro, 2008). This has mainly affected small holder farmers.

Nyagumbo, Mbvumbi and Mutsamba (2009) suggest that erratic rainfall patterns (Figure 1), which have become frequent over the years, have affected production further and yields have declined tremendously overall with complete crop failure in some areas in years with extended dry spells. All these factors have impacted negatively on crop productivity and have led to food shortages for the people in Chiwundura communal area, which experiences high temperatures and low rainfall. To help to address these, there has been major investments and policy drive towards conservation agriculture as a way of improving crop productivity through efficient use of production inputs, improved management, timeliness of operation and conserving the soil (Giller et al., 2009).

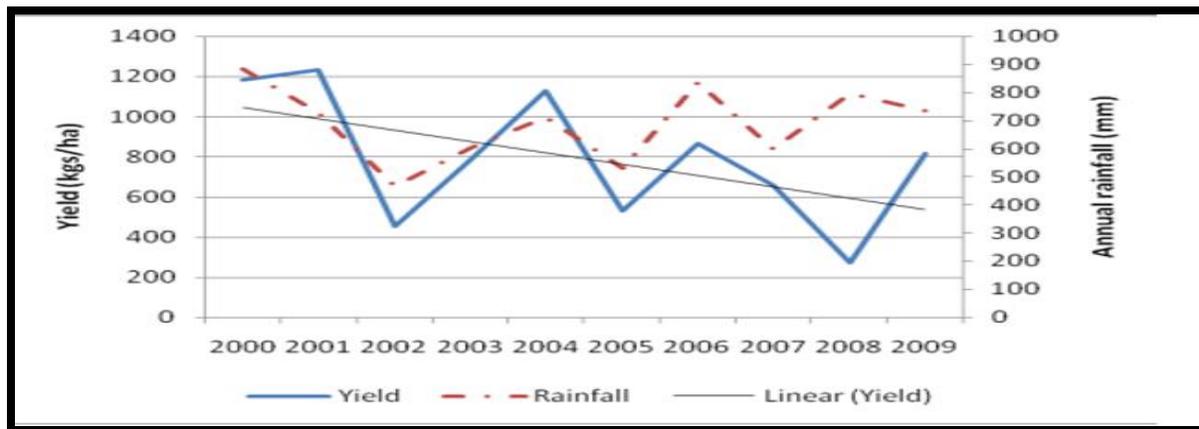


Figure 1: Variation in Zimbabwe national average maize yield. Source: (MAMID, 2012).

Conservation agriculture has been promoted in the communal wards of Chiwundura communal area which are ward 10, 11 and 12. However, policy adoption which translates into conservation agriculture expansion is influenced by a number of technical, institutional, agro ecological, cultural and socio economic factors.

#### 1.4 Problem statement.

Despite the promotion by the national extension programs and numerous other projects, conservation agriculture adoption has been extremely low in the small holder sector (Hobbs, 2007) and farmers in Chiwundura communal area are among them. Among the common reasons for low adoption are low degree of mechanisation within the small holder system, lack of appropriate implements, problem of weed control, access to credit and lack of appropriate technical information for change agents.

#### 1.5 Research problem.

The reasons given by small holder farmers in Chiwundura communal area for adopting or not adopting conservation agriculture practices are not known. It is because of this reason that justifies a research from the agricultural extension services department to gain a profound insight from farmers' perspective on the reasons for adopting or not adopting conservation agriculture practices.

#### 1.6 Justification.

It is important for the stakeholders to understand the dynamic of adoption of any intervention. As such getting an insight on the determinants of adoption becomes of paramount importance so that there is communication between farmers and the implementers of the technologies so that there is policy formulation aimed at addressing conservation agriculture options that suit into farming system of the farmers for improving crop productivity, hence food availability.

### **1.7 Objective.**

The research objective is to contribute to implementation of conservation agriculture options that suit into the small holder farming system for improved crop productivity by gaining an insight into the reasoned opinions of Chiwundura farmers for adopting or not adopting conservation agriculture practices.

### **1.8 Main research question.**

What conservation agriculture practices are considered appropriate for the farmers in Chiwundura communal area?

To try to answer the main question, the following sub questions were formulated.

#### **Sub questions.**

- a) What conservation agriculture practices are being promoted to farmers by extension workers in Chiwundura communal area?
- b) In what ways do conservation agriculture practices promoted fit into the farming system of Chiwundura communal area?
- c) What are the bottlenecks of conservation agriculture in Chiwundura communal area?
- d) What are the possibilities of translating conservation agriculture successfully to small holder farmers in Chiwundura communal area?

### **1.9 Organisation of thesis.**

The thesis is composed of 6 chapters. Chapter 1 provides some background information on Zimbabwe, agriculture sector and the farming system study area, problem definition, problem statement, research problem, justification, study objective and research questions. Chapter 2 introduces background information on conservation agriculture in Zimbabwe and the theory of conservation agriculture adoption. Chapter 3 provides information on the study area and methodologies employed. Chapter 4 presents an overview of the results. These are then discussed in Chapter 5. Conclusion and recommendations drawn from the study are presented in Chapter 6.

## **Chapter 2: Literature review.**

This section defines the terms used in this study. It gives a background of conservation agriculture demonstration in Zimbabwe as well as the current practices by the small holder farmers. The section also briefly outlines the model used in the study and literature from other studies.

### **2.1 Definition of terms.**

#### **Conservation agriculture**

Conservation agriculture as defined by Twomlow, et al. (2008) encompasses activities such as minimum tillage and zero tillage, tractor powered and manual methods, integrated pest management, integrated soil and water management and includes conservation farming. Conservation farming on the other hand encompasses the use of planting basins and soil cover and has been used interchangeably with conservation agriculture as if they mean the same meaning. Dumanski et al. (2006) define conservation agriculture as to all modern technologies that enhance the quality and integrity of the soil. For the purpose of this study the concept conservation agriculture focuses on the 3 principles promoted by FAO which are minimum soil disturbance, continuous soil cover and crop rotation which are the main aspects known by farmers and AGRITEX extension workers.

#### **Farming system.**

FAO (2012) defines farming system as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategy and interventions would be appropriate.

#### **Small holder farmer.**

Cousins (2010) defines a smallholder farmer as a producer who occasionally sells products for cash as supplement to other sources of income, to those who regularly market a surplus after their consumption needs have been met; and those who are small scale commercial farmers with a primary focus on production for the market. Syngenta (2013) defines small holder farmer as a small scale and subsistence level farmer in resource poor conditions operating with few purchased inputs and limited technology. For the purpose of the study Syngenta's definition of a small holder farmer is to be adapted.

## **2.2 Conservation agriculture demonstration in Zimbabwe.**

The government extension department (AGRITEX) has set up conservation agriculture demonstration across the country. The commonly used is planting basin demonstration where planting basins are made followed by fertilizer application, planting and leaving a layer of mulch within planting rows. Promotion of the technology has been done by demonstrations in the field and farmers are supported with inputs. Farmers are handed out a package of hybrid seed and compound D per participating farmer. AGRITEX collaborates with other organisations such as Christian care for allocation of funds for training of extension workers and farmers on conservation agriculture. At least 35 AGRITEX extension workers are trained and 20 demonstration plots are established in each district. The target groups for promotion of conservation agriculture by development partners have been the poorest and most vulnerable small holder households with limited access to draught animals. The selected beneficiaries have a minimum plot size of 0.5 hectares and the farmers should be willing to learn and mentor others.

There are basically two approaches used by AGRITEX in demonstration of conservation agriculture practices. These are the extension agent system where extension workers work directly with groups or cluster of farmers and support them in the implementation of conservation agriculture intervention on their own fields. The lead farmer system, where trained extension agents work with lead farmers in a community and in turn these farmers work with farmer groups. Farmers are organised (mentored farmers) around a focal farmer (lead farmer). Members of the cluster groups would use the lead farmers plot as a training field for conservation agriculture practices. The lead farmer receives inputs from the programme for training purposes and training on conservation agriculture from the district conservation agriculture training team. The lead farmers will then visit mentored farmers home plots for assessment at all stages of the project implementation. However, the lead farmer system is not common in Chiwundura and the extension agent system is the commonly used approach. Extension workers have been leading in extension service and the farmers have been persuaded to adopt new practises or innovations. This top down model creates a rigid hierarchy which discourages the feedback of information from farmers. The extension workers role is to teach and demonstrate to innovative contact or master farmers on how to use new technologies. Among elements taught by extension workers on demonstration are, how to operate the conservation agriculture equipment which are the hand hoe, ripper, jab planter and direct seeder as well as crop rotation and the level of mulch required. Once innovative farmers have adopted the new technologies, the extension theory assumes a diffusion model where other 'laggards' or 'followers' farmers will copy them and the technology will diffuse to the majority of farmers.

### **2.2.1 Current conservation agriculture practices in Zimbabwe.**

The conservation agriculture option that has been promoted in Zimbabwe is a manual system based on planting basins that act as planting stations for the crops (Twomlow, et al., 2006). This option was promoted mainly to address the draught power shortages in the communal farming sector which delays and consequently negatively affects final crop yields. This strong focus on planting basins is currently shifting in Zimbabwe as more organisations are interested in also serving more resource endowed farmers with animal and tractor drawn conservation agriculture options. Mechanised conservation agriculture has been widely used by commercial farmers in Zimbabwe and has since dated back from 1970s. Large scale commercial farmers often have access to these conservation agriculture equipment compared to the small holder farmers.

Planting basins are uniformly spaced holes (15cm x 15cm x 15cm) which are dug in a line running across the main slope in the field (Breton, 2012). (Figure 2). Manure and/or fertilizer are precisely placed into each basin, rather than broadcast, saving on resources. Basins are dug manually with a hoe during the winter period so that labour is distributed over a longer period and the crop can be planted with the first effective rains. Basins leave over 90 percent of the soil area undisturbed, capture run off water and benefit from precise fertilizer placement. Basins should be made in the same place each year and, after initial formation, do not need as much labour to re-form. Because of the concentration of water and initial rains in the basins, the benefits can be apparent in the first season. However, basins do require considerable labour, especially in the first dry season when soils can be very hard and difficult to dig.

The basins may be made at any time before the growing season so that the farmer is ready to plant on time. The planting basins are maintained for use in subsequent years, saving on labour. The advantage that planting basins have over other practices is it costs less compared to rippers and direct seeders.



Figure 2: Planting basins: Source (ZimbabweLand, 2012).

The jab-planter for conservation agriculture is a manual implement with two points that are pushed into the moist soil through the mulch, and opened to release the seed and fertilizer (figure 3). The jab planter is quicker than hoe or pointed stick methods. Once the technique is mastered, seed and fertilizer can be placed with more precision. However, experience is needed to be able to seed well and accurately, and in wet clay soils, seeding can be difficult as soil sticks to the points. Jab planters are also more expensive compared to hoes or pointed sticks, and are still difficult to purchase.



Figure 3: Farmers using jab planters in a demonstration. Source :( FAO, 2005).

Rippers are attachments fitted to the plough frame (figure 4). They were developed to open furrows for moisture capture or to break superficial compacted layers, but in conservation agriculture they work well to open planting furrows. The animal-drawn magoye ripper works at a shallow depth (10-15cm) and, after making the rip line, seed and fertilizer are placed manually in the furrow and covered. Other rippers such as knife rippers can be found in the region, but are not as common. The ripper has advantages such as low-cost modification to the plough, the ripper uses less energy and labour than the plough and can be used with smaller or weaker animals and timely planting is possible if animals are available. However, ripper has some challenges such as residues often get caught and dragged, seeding and fertilizer application have to be done by hand, which is labour expensive and planting is delayed if oxen are not available.



Figure 4 A plant ripper. Source: (FAO, 2005).

Direct seeders are designed to seed into surface mulch in untilled soil. The implement has separate seed and fertilizer bins and a cutting disk (coulter). The coulter cuts through the residues, a ripper tine opens a furrow, and the seed and fertilizer are placed in the furrow—all in a single operation (figure 5). Seeder units are manufactured for both oxen and donkeys. A direct seeder has advantages such as; seeding with the animal traction seeder is fast and efficient, direct seeding disturbs little soil and higher yields are generally achieved than with ripper and hand systems. Direct seeders have disadvantages of relatively being expensive and not readily available to small holder farmers, residues have to be dry to enable the coulter to cut through the mulch, seeding depth has to be carefully calibrated and animals need to be trained.



Figure 5: Direct seeder mounted on oxen. Source (Feed for the future, 2012).

### **2.3 Conceptual framework.**

Adoption of conservation agriculture is affected by many factors such as socio economic factors, technical attributes, bio physical factors, institutional factors and cultural factors. According to Leeuwis and van der Ban (2004), adoption hangs together with four conditions; namely the farmer must want to, know how, be able to and be allowed to follow the requirements of the farming practice being promoted. Therefore, these four conditions are influenced by the adoption factors. For the purpose of the study, the author focused on socio economic, technical attributes, institutional and cultural factors. In order to understand the reasons for adopting or not adopting conservation agriculture, the conceptual framework adapted from the sorting scheme was applied (Figure 6).

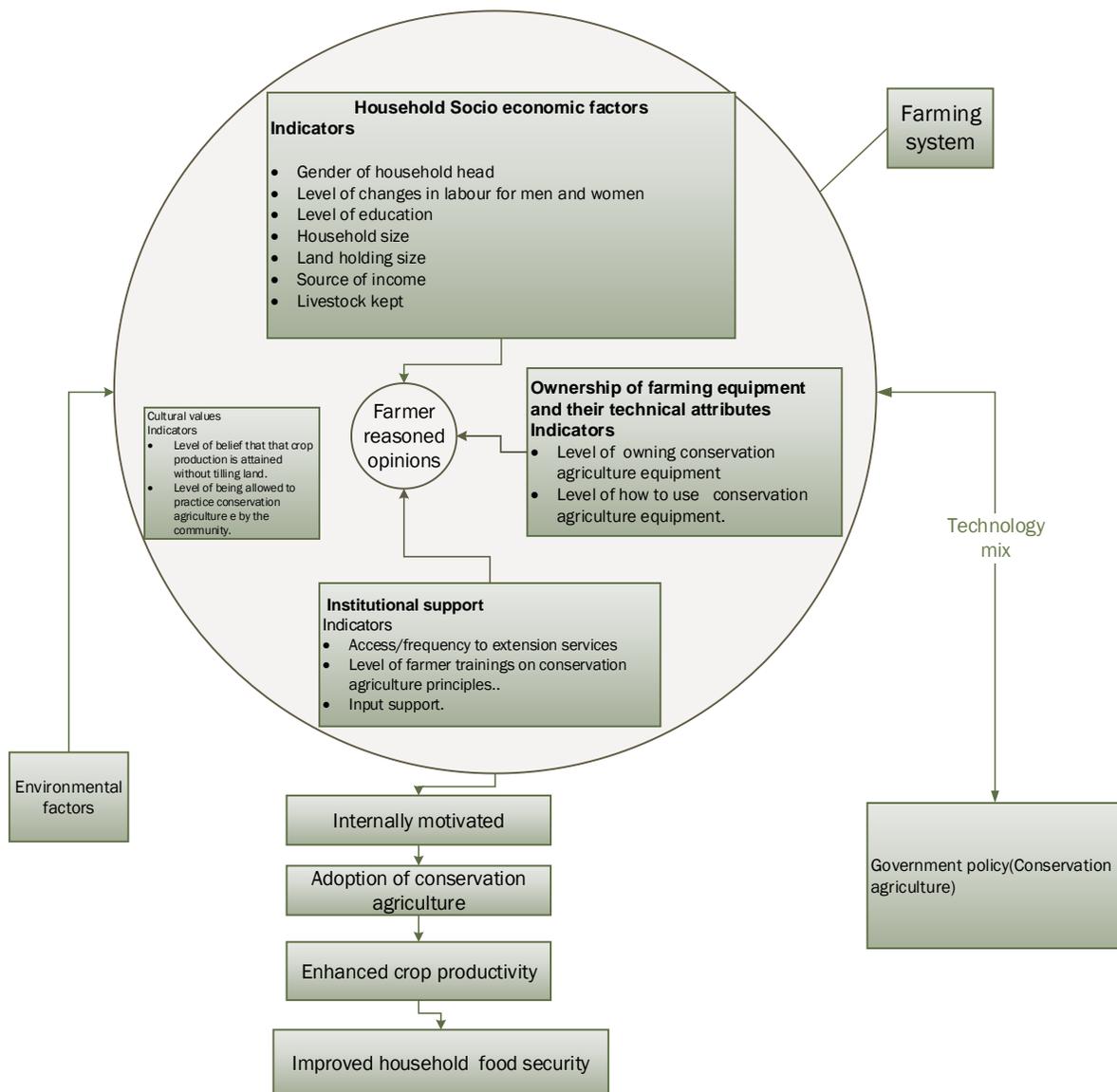


Figure 6: Conceptual framework for conservation agriculture adoption adapted from sorting scheme .Source :( Leeuwis and van der Ban, 2004).

### 2.3.1 Conservation agriculture adoption worldwide.

Adoption of new agricultural technology is associated with main constraints farmers face when making decisions to adopt. These include various determinants such as agro ecological constraints, credit constraints, input supply constrains or cultural values. Likewise the adoption of conservation agriculture is subject to most of these constraints found in the literature but however, the constraint that will be more binding is very context specific and therefore varies from one place to another.

Conservation agriculture is a technology and management system that has demonstrable potential to secure sustained productivity and livelihoods improvements for millions of climate dependent farmers working in semi-arid areas around the world. Success stories have been recorded for some countries in Asia, Australia and Brazil. According to IFAD (2011), it is

estimated that approximately 47 percent of conservation agriculture technology is practiced in South America, 39 percent in the United States and Canada, 9 percent in Australia and about 3.9 percent in the rest of the world, including Africa, Asia and Europe. However, for Sub Saharan Africa adoption of the technology has lagged behind these other countries. Therefore, in Sub Sahara, conservation agriculture may be perceived as a risk investment because farmers will need to learn new practices. Therefore, the success stories of conservation agriculture in other countries cannot be the same in another countries given the varying conditions between the countries, thus the feasibility of conservation agriculture has to be looked at it critically and analysing the farming systems in a given context.

Looking at the small holder farmers, financial constraints will affect adoption when initial costs are high such as purchase of inputs, conservation agriculture equipment, herbicides and sprayers. Conservation agriculture increases labour requirements for weeding when implemented without herbicides as is the case with most small holder farmers in Sub Sahara. Therefore, labour constraints may be binding for households who do not have access to herbicides and enough labour. Agro ecological constraints such as soil type and climate are also likely to affect adoption. Maintaining permanent soil cover can also be costly for the small holder farmers. Incorporating crop residues as mulch after post-harvest present opportunity cost as crop residue has traditionally been used for other purposes such as livestock feed, fuel and etc.

The promotion of conservation agriculture has therefore brought controversy in smallholder farming system in sub Saharan Africa. Many factors tend to hinder the adoption of conservation agriculture and therefore concerns have been raised on the suitability of the technology within the small holder farming context. Benefits in reduced erosion and stabilized crop production may be obtained, but technical performance at field level is but one of the determinants of conservation agriculture adoption and as suggested by Giller, et al. (2009) that all of the conservation agriculture principles are not always fully implemented by farmers and results not as favourable as expected. The authors further highlighted that concerns include potential decrease in yields due to poor adaptation of conservation agriculture, increased labour requirements when herbicides are not used, competing uses of crop residues as mulch for soil cover and livestock feed, and potential redistribution of farm labour, placing a higher demand on women's time. Given these conditions in which small holder farmers in Sub Sahara operate, conservation agriculture needs to be re packaged to suit their farming system.

Although Conservation agriculture has been widely promoted and demonstrated in Zimbabwe by the national extension program and numerous other projects, adoption has been extremely low in the small holder sector, compared to other continents such as South America, North America and Europe (Hobbs 2007, Derpsch 2008, Gowing and Palmer 2008). To support this, a survey conducted on conservation agriculture in Gutu (Zimbabwe) by Mika and Mudzimiti (2012) found out that only 6 percent of trained farmers practice conservation agriculture on their pieces of land. The authors further on asserted that for farmers not to practice conservation agriculture is not entirely their fault but the caliber of extension agents at the farmers' disposal who are not able to carry out such operations as pegging to make basins. The services provided to farmers by extension agents can affect adoption and the extension agents need to be well equipped and

support the farmers technically but however, on the other hand it depends with the farmer's socio economic conditions.

Whilst there is low adoption, Gowing and Palmer (2008) examined evidence of conservation agriculture benefits amongst small scale farmers in Africa and concluded that conservation agriculture does not overcome constraints on low external input systems. They noted that conservation agriculture will deliver the productivity gains that can achieve food security only if farmers have access to fertilisers and herbicides. They further asserted that adoption of conservation agriculture by small scale farmers is likely going to be partial as opposed to full adoption. The authors are supported by Giller, et al. (2009) who noted that there are many cases where adoption of conservation agriculture was temporary and only lasted for the course of active promotion of the technology by NGOs and research institutions but was not sustained beyond that. Mazvimavi, et al. (2000) also found out from a study conducted in Zimbabwe that 11 percent of the interviewed farmers had stopped conservation agriculture practices by 2008/09 season cropping season due to withdrawal of input support. To complement the authors, Nyanga et al. (2011) conducted a survey for 469 farmers in 12 districts in Zambia and found out that a widespread expectation of subsidy, input package or material rewards of conservation agriculture, which they argued had developed as a result of previous programs use of such incentives. This is concordant with the finding of Baudron et al. (2007) who reported that 50 percent of farmers dis adopt conservation agriculture if they no longer qualify for such incentives.

A different picture is given by Marongwe, et al. (2011) who suggested that the total number of farmers in Zimbabwe practising conservation agriculture options during the 2010/2011 agricultural season had increased tremendously, with a significant proportion implementing conservation agriculture without any input support, showing increasing appreciation of conservation agriculture benefits by farmers. They further on emphasised that despite the increasing adoption, farmers still face challenges in maintaining adequate ground cover due to the communal grazing system that are observed in most areas and high labour demands of hand based conservation agriculture systems for land preparation and weed management. A different view is given by Haggblade and Tembo (2003a) who suggested that in Zambia 205 of conservation agriculture farmers in the 2002/2003 season were spontaneous adopters, with the 80 percent majority practising conservation agriculture as a condition for receiving subsidised inputs package. Given these statistics from various areas, input support is mainly seen as the reason why farmers adopt conservation agriculture but however, this also depends with the context small holder farmers operate and critical analysis therefore is required.

A study conducted in Ethiopia by Tsegaye, et al. (2000) found out that adoption of conservation agriculture is influenced by regional location, family size, access to extension and formal education. On the other hand, Nkala, et al. (2011) conducted a meta-analysis of conservation agriculture and focused mainly on the constraints to a successful implementation of conservation agriculture projects in Southern Africa. They discussed such issues as the lack of infrastructure, existing livestock norms, imperfect input and credit markets and land tenure as obstacles that limit widespread adoption in Southern Africa. Fanelli and Dumba (2006) noted that introducing conservation agriculture to community members requires patience,

understanding, and careful explanation to convince them to adopt an alien farming practice. They further noted that aspects of conservation agriculture may initially seem unusual to community members, and it may take time for them to overcome their skepticism and understand the new approach as well as advantages over the traditional conventional farming methods.

The rapid adoption of conservation technologies by large as well as small holder farmers in many areas of the world, often without government support, is clear evidence of the economic, environmental and societal benefits that accrue from these practises (Dumanski et al., 2006). In contrast, Giller, et al. (2009) argued that although there are claims about widespread of conservation agriculture adoption, there is available evidence that suggests virtually no uptake of conservation agriculture in most Sub Sahara Africa countries with only small groups of adoption in South Africa, Ghana and Zambia. However, a different picture is revealed in South Asia where Hobbs, Sayre and Gupta (2005) suggested that there was a rapid adoption of zero till adoption in the last 5 years due to farmer participatory approaches which allowed farmers to experiment with the technology in their own fields and promotion of the local machinery manufacturers in the region. Contrary to the reasons for uptake, FAO (2012) suggested that the adoption of conservation agriculture would be extremely beneficial in Central Asia because the conventional agriculture is virtually impossible because of environmental problems (erosion) and lack of farm machinery. In addition, FAO (2012) also ascertained that conservation agriculture is low in Europe because farmers do not feel sufficient pressure and environmental indicators such as erosion and flooding are not yet taken seriously. Therefore adoption of conservation agriculture varies from place to place depending on various factors and implying that the suitability of conservation agriculture is context dependent.

### **2.3.2 Crop yield benefits from conservation agriculture in Zimbabwe.**

Conservation agriculture currently has been widely promoted mostly to poor small holder farmers in Zimbabwe to address food shortages and farmers have shown a growing interest in conservation technology with evidence of yield gains of between 10 and more than 100 percent depending on input levels and the experience of the farm households (Mazvimavi, 2009). Conservation agriculture allows farmers to plant early and leads to a good crop stand which gives higher yields. Conservation agriculture yield benefits began to be realised from large scale farmers using mechanised equipment where an average yield of 3 tonnes per hectare for maize was achieved. The benefits of conservation agriculture are therefore now targeted to small holder farmers who do not have access to inputs and have poor soil fertility. Yield levels in Zimbabwe across different agro ecological regions and crops showed improvements of up to 67 percent for maize, sorghum and groundnuts. Much of the improvements was attributed to improved management, early planting, frequent weeding and fertilizer application. According to FAO (2011), an estimated 300 000 Zimbabwe farmers had adopted conservation agriculture and these farmers had been able to harvest maize from their small plots, averaging 2 tonnes per hectare for maize which is nearly a triple what they produced under conventional agriculture (Figure 6). The increase in yields actually provides a surplus they can sell, thereby improving their livelihoods while contributing, to the national basket.

According to Twomlow, et al. (2008) conservation agriculture has consistently increased average yields by 50 percent to 200 percent in more than 40 000 farm households with the yield increase varying by rainfall, region, soil type and fertility. Conservation agriculture enables diversification in cropping patterns and more reliable legume production. According to ZCATF (2009) conservation agriculture has multiple benefits for the households and communities and for the environment. Farmers can get maximum benefits if they apply the key principles which are minimum soil disturbance, mulching, crop rotation timely implementation, precise operations and efficient use of inputs. In this case, maximum productivity is only achieved when conservation agriculture is practised to a high standard. Therefore, the main focus of conservation agriculture has been on high management levels and good extension work, optimising all resources through best land and field practises. The ability of farmers to practise the principles of conservation agriculture therefore remain of paramount importance but however, farmers in the small holder sector do not practise all the principles given their socio economic context and this presents a criticism on the claimed high yields associated with conservation agriculture.

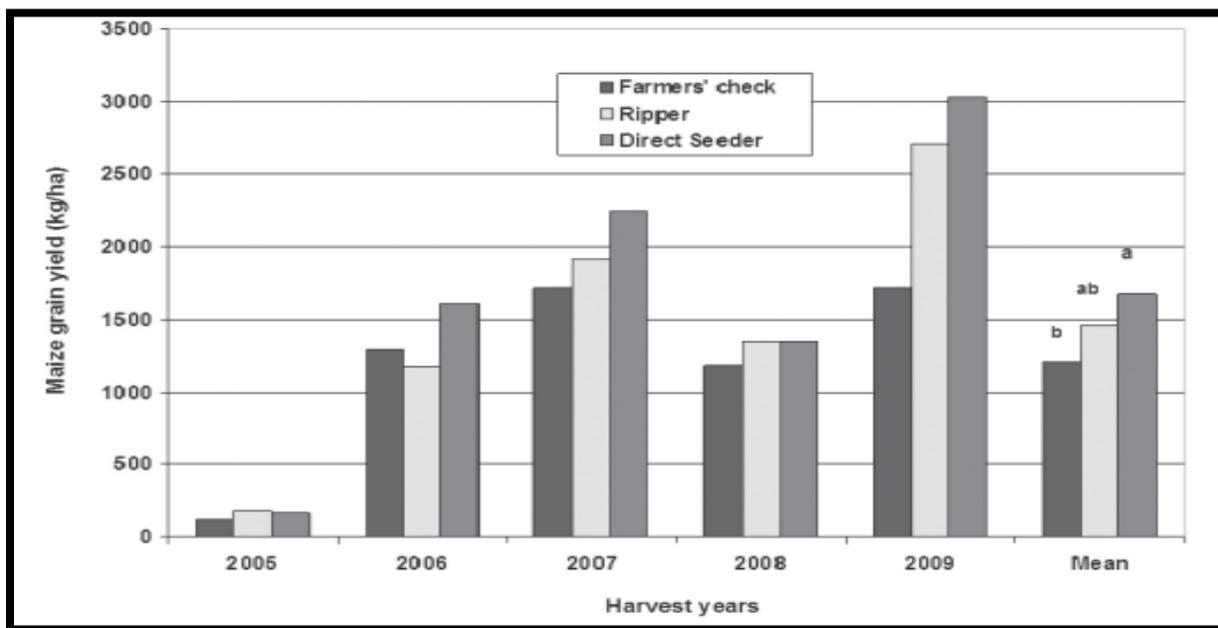


Figure 7: Maize yield under conservation agriculture. Source: (Marongwe, et al., 2011).

### 2.3.3 Global impact of conservation agriculture.

The impact of conservation agriculture to small holder farmers has been viewed as contributing to improved productivity yet in some instances it is not the case. This brings confusion into the feasibility of the practises yet it is increasingly dominating in Africa. The results of some studies carried out in Brazil suggest that conservation agriculture results in more biotic diversity in the soil as a result of the mulch and less soil erosion(Hobbs, 2005). This also produces higher surface soil organic matter than when soils are tilled. On the other hand research carried out in Pakistan under dry land conditions showed that lower yields were achieved under no till compared to a tilled land because the experiment was planted with improper equipment and

with no residue management (Iqbal, et al., 2005). In a study conducted by International Crops Research Institute For The Semi-Arid Tropics (ICRISAT) who compared yields from farmers practising conservation agriculture (planting pits) with farmers using conventional techniques and found that average yields were 80 percent higher than from conventional farming (Wagstaff and Harty, 2010). In contrast, there also other studies that presents a sharply contrasting assessment of conservation agriculture impacts. Giller, et al. (2009) suggested that empirical evidence is not clear and consistent on conservation agriculture contribution to yield gains. Their study also notes concerns that include decreased yield in conservation agriculture, increased labour requirements when herbicides are not used, a shift to the labour burden to women and problems with mulching requirements due to its shortage or competing use as livestock feed. To complement this, a study conducted in the Mid Zambezi valley in Zimbabwe, Baudron, et al. (2012) suggested that under conservation agriculture, cotton yield decreased. They further on asserted that farmers perceived ploughing as necessary during drier years to maximise water infiltration, but perceived conservation agriculture as beneficial during wetter years as a means to shed water and avoid water logging under mulch conditions. In contrast conservation agriculture was shown to increase farmers' crop income in Zambia's cotton belt through both higher yields and the cultivation of larger fields. The result was true for the poorest households though the magnitude of the income increase was greater for wealthier households who could afford chemical inputs (Hagblade, Kabwe, and Plerhoples, 2011).

Rusinamhodzi, et al. (2011) found that maize yielded less under no tillage (conservation agriculture) without rotation compared to conventional tillage but more rotation was practised. They concluded that maize yields under conservation agriculture in Southern Africa depends on the ability of farmers to practise crop rotation and given that they plant legumes on 5% of the land and proposed that conservation agriculture needs to be repackaged to reflect the diversity of farming systems and other biophysical and socio economic considerations for improved impact. To support this, Anderson and Giller (2012) suggested that there are different conservation agriculture packages; the suitability and application of conservation agriculture in highly diverse small holder farming systems remain contested. They further on highlighted that actual adoption of conservation agriculture will be patchy at best as it is only suited to the circumstances of local conditions. Given these circumstances not all conservation agriculture practises promoted fits into the farming system of farmers given all the reasons discussed and farmers in Sub Sahara are the most affected because of various constraints.

#### **2.3.4 Suitability of various conservation agriculture practices to various categories of farmers.**

Because of heterogeneity among small holder farmers in Zimbabwe, significant differences occur because of widely varying socio economic conditions, assets ownership and agro ecological conditions, blanket agricultural recommendations rarely prove appropriate and conservation agriculture practices are no exception to this rule (Haggblade and Tembo, 2003b). According to Haggblade and Tembo (2003b), over 75% of Zambia 870 000 farmers operate holdings of less than 5 hectares and available evidence suggests that the overwhelming majority of farmers use hand hoes. Rippers on the other hand, are commonly used by medium–scale farmers who cultivate 5 to 20 hectares of land and own cattle and require animal traction to farm such large area. This conservation agriculture practice involves dry season ripping, normally with the locally developed Magoye ripper. Animal traction conservation agriculture is used in parts of Zimbabwe and Zambia where there is a tradition of cattle ownership and plowing with oxen. In many other areas where manual land preparation is prevalent conservation agriculture takes the form of planting basins and direct seeding with a jab planter or dibble stick. On the other hand, commercial farmers use mechanised minimum tillage methods with leguminous crop rotation such as soya beans complete the ladder of conservation agriculture technology (Haggblade and Tembo, 2003b).

Mechanised conservation agriculture has been adopted in places where there is abundant land and is used in parts of South Africa, Zimbabwe and Zambia among large–holder commercial farmers. Extensive work and application by Zimbabwean commercial farmers at their privately financed Agricultural Research Trust (ART) further stimulated local interest in low till technology. The growing need of minimum tillage commercial farming was also as a result of high fuel costs as farmers could discover that these low mechanised till cultivation could enable them to reduce fuel consumption from 120 to 30 litres per hectare (Haggblade and Tembo, 2003b). The planting basin variant explicitly caters for small hand hoe farmers without reliable access to draught power. Thus in a given farming system there area variations among farmers in terms of their socio economic status.

## Chapter 3: Research strategy and methodology.

This section discusses the study area, the methodology and data analysis.

### 3.1 Study areas and collection methodology.

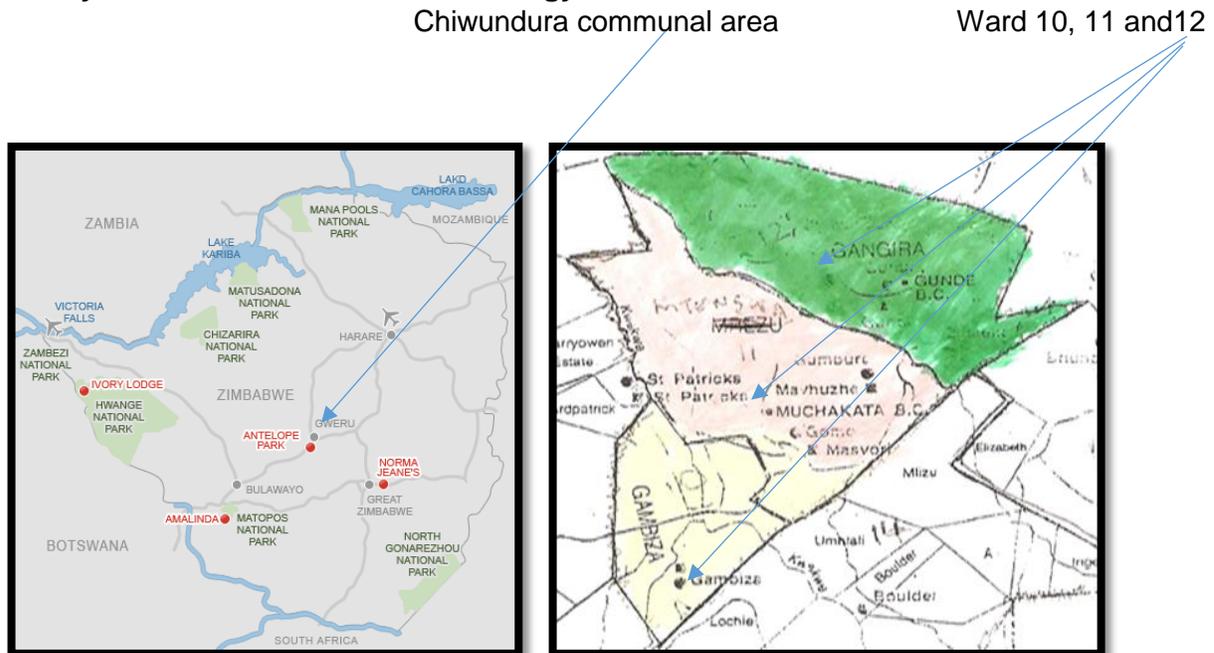


Figure 8: Map of Zimbabwe and the study areas in 3 wards in Chiwundura communal area.

The study was carried in 3 wards (10, 11 and 12) in Chiwundura communal area which is located 20 km North East of city of Gweru as shown by figure 8. It is bounded by Kwekwe district (North), Mvuma district (East), Gokomere small scale (West) and Umsungwe block (South) in Gweru district situated in the Midlands Province of Zimbabwe. The reason for selecting Chiwundura communal area is because it is the area where conservation agriculture is being promoted owing to its low rainfall and high temperature. Chiwundura communal area falls into the agro ecological zone 3 which is characterised by an average rainfall of 650-800mm distributed between November and March. As shown by figure 9 the rainfall amounts in these 3 wards decreased significantly in 2009/2010. The summer is generally wet and hot and winter is cold and dry with occurrence of frost. The vegetation in ward 10 consists of acacia and mopane type of vegetation whereas ward 11 and 12 consists of msasa trees and thorn bushes. Livestock farming is practiced where cattle, sheep, goats, donkeys, pigs and poultry are kept. Conservation agriculture dominates the communal wards where CARITAS an NGO provided inputs for 789 farmers in ward 10, 957 in ward 11 and 968 in ward 12.

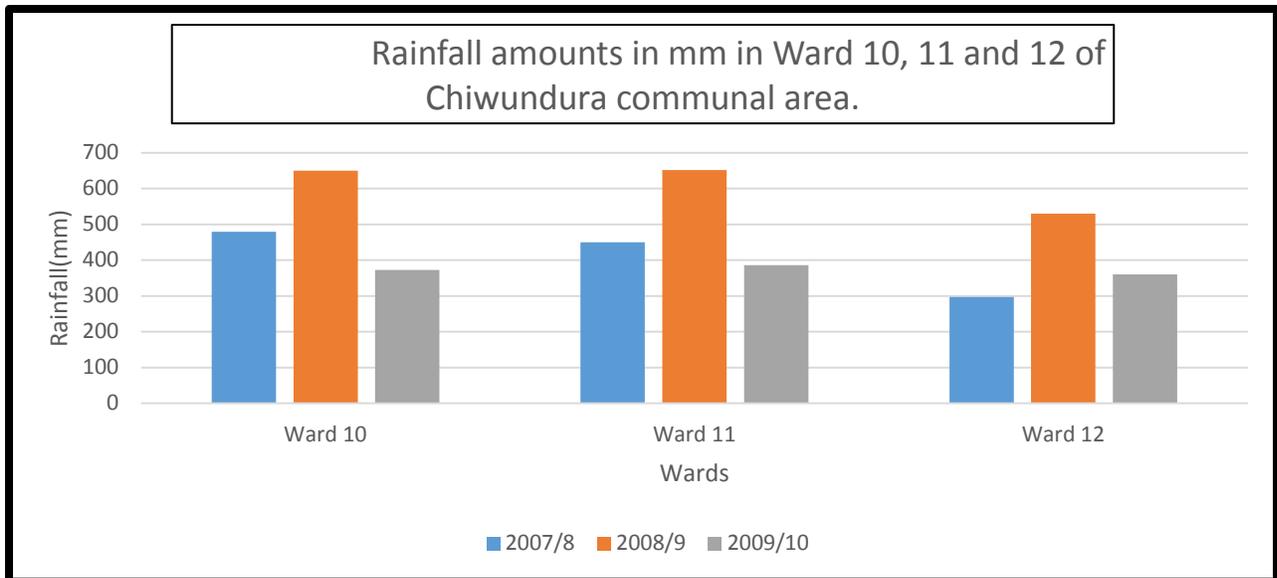


Figure 9: Rainfall amounts in ward 10, 11 and 12 of Chiwundura communal area. Source: Author.

The research had a quantitative and qualitative approach based on empirical data and secondary data collected through desk study (figure 10). Data collected through desk study was on the background information on the research topic as well as the global perspective of conservation agriculture. Before farmers were interviewed, a verbal guarantee was made to the farmers that the interviews were confidential and only used for the purpose of the study and responses given were meant for the recommendations in the department of AGRITEX.

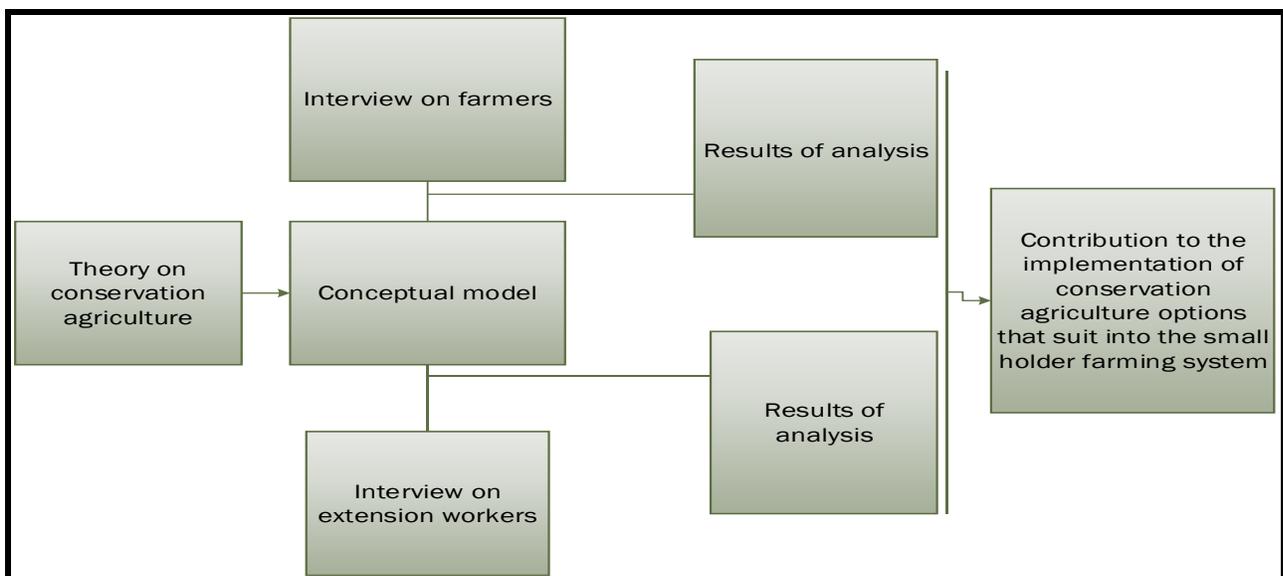


Figure 10: Research framework. Adapted from Doorewaard and Verschuren (2010).

### 3.2 Research strategy.

A case study was used to get an in depth information on the influence of household socio economic, technical attributes, institutional and cultural factors on adoption of conservation agriculture. The case study was to get a more detailed and broader understanding of these factors and how they influence adoption. 24 respondents were selected and categorized into farmers practicing conservation agriculture, farmers who stopped conservation agriculture and farmers who never practiced conservation agriculture. The reason for selecting these categories was to find out similarities and differences on the factors affecting adoption.

#### Data collection method.

**Sampling;** Random sampling of one village from ward 10, 11 and 12 (all communal wards) was done to avoid bias, thus 3 villages were selected. The reason behind was to cover all the wards where conservation agriculture has been promoted. A list of farmers was provided by extension workers and grouped into categories. Random sampling from each category was done to avoid bias. 24 households were grouped into 3 categories. 12 farmers practicing conservation agriculture were randomly selected. Conversely, 12 farmers who did not practice conservation agriculture were randomly selected and categorized into 6 farmers who have stopped practicing conservation agriculture and 6 farmers who never practiced conservation agriculture. Random selection was done by putting the names of farmers in a hat and picking the farmers randomly.

Table 2: Justification summary for the chosen methods.

Data collection method	Population	Justification
Semi structured interviews with farmers	24 farmers from 3 wards	To get an in depth information on the reasons why farmers have adopted or not adopted conservation agriculture on three farmer categories. To probe further the interviewee to get the required information.
Semi structured interviews with key informants.	3 extension workers	For triangulation of information, providing data on labour requirements and crop production statistics.

**Semi structured Interviews with farmers;** Data was collected through interviews and observation for data validity. A one to one interview with 24 farmers using a structured questionnaire which is shown in Annex 1 was done. The structured questionnaire was uniform to all categories of farmers being interviewed for comparison and evaluation. The data collected from the interviews was to understand how the factors influence adoption. Pretesting of the questionnaire was carried out. This was to find out if the research questions were being answered. Adjustments were made on some part of the structured questionnaire. The semi structured interview allowed an opportunity to probe further to explain some of the answers.

**Semi structured interview with key informants;** 3 key extension workers from AGRITEX department from ward 10, 11 and 12 were interviewed to get their views on their training on conservation agriculture, how they promote conservation agriculture, their views on conservation agriculture practices fitting the farming system and challenges. Extension workers also provided information on labour requirements and costs on digging planting basins and conventional tillage as well as crop production statistics for conservation agriculture and conventional tillage. A check list which is shown in Annex 2 was used.

### **3.2.1 Analysis of results.**

The excel sheet was used to analyse data from the structured questionnaires from all the categories of farmers. Tables and graphs were generated to show the adoption factors that influence the adoption of conservation agriculture. This was also supported with content analysis from the farmers. Results are shown in Chapter 4.

### **3.3 Limitation of the study.**

The research was carried out in July and August which is a post-harvest period for field crops and was therefore not possible to observe farmers in action as they start to prepare the land for conservation agriculture in September. Data collection was carried out during and immediately after election period and this made it difficult for the full attention of the farmers. However, the information gathered was credible to make recommendations.

## Chapter 4: Research findings.

This chapter presents findings from the farmers on the socio economic, technical attributes, institutional and cultural factors influencing conservation agriculture adoption in Chiwundura communal area.

### **4.1 Conservation agriculture practices promoted by extension workers in Chiwundura communal area.**

The research findings reveal that the common conservation agriculture promoted in Chiwundura communal area is the planting basins literally known in Zimbabwe as “*digha udye*” meaning dig and eat. Every interviewed farmer from all the categories highlighted to have been trained on planting basins and therefore it is the most common practice. Data gathered from the interviewed farmers suggest that regardless of whether the farmers are still practicing conservation agriculture, or have stopped practicing conservation agriculture or they never practiced conservation agriculture are familiar with planting basins. The reason is most farmers in Chiwundura communal area are resource poor and the planting basins which are dug by the hoe are cheap. In this case the planting basins fit into the farming system of Chiwundura communal area as farmers can easily get the hand hoe. The study also reveal that other conservation agriculture practices such as the use of jab planters, rippers and direct seeders are promoted by extension workers albeit on a small scale.

### **4.2 Planting basins fitting into the farming system of Chiwundura communal area in terms of socio economic factors.**

**Gender of the household head practicing conservation agriculture;** As conservation agriculture adoption is influenced by differences in gender of the household head, data collected in Chiwundura communal area shows that there were more female headed households practicing conservation agriculture than male headed households as shown by figure 11. This is because men migrate to neighbouring countries to look for employment leaving women doing agricultural activities. It was also shown that female headed household with smaller household size tend to limit the area put under conservation agriculture due to shortage of labour. One interviewed farmer could be quoted saying,

*“My husband passed away and have 2 other members in the household to help me and my land size is about 2 hectares and I don’t plant it all under conservation agriculture due to shortage of labour.”*

Therefore because farmers do not put all area under conservation agriculture due to labour constraints, pose a constraint for the farmers in the farming system of Chiwundura communal area.



Figure 11: Number of male and female headed practicing conservation agriculture.

Whilst more females than males were involved in conservation agriculture the research findings also reveal that there were more females than men who stopped practicing conservation agriculture. The same is also revealed for farmers who never practiced conservation agriculture. This because females have competing labour demands with household chores which affect adoption.

**Labour changes in men and women;** From the interviews from the farmers reveal that women face constraints in doing field activities compared to men. All the interviewed farmers from all the categories of farmers, females expressed concern of competing demands for labour with household chores. A female was quoted saying,

*“Since I am an old female I find it hard to dig basins as I have to do other household chores at my home. If my family members come, I don’t know when, that’s where I will practice conservation agriculture.”*

On the other hand, males who were interviewed, only one highlighted that he had competing demands of labour because he is employed. It can then be concluded that the planting basins pose labour constraints to the households and not fitting properly into the farming system. The labour constraints therefore affected female headed households more than male headed households.

**Level of education;** The level of education from the literature has been shown to influence adoption of conservation agriculture but the findings in Chiwundura communal area reveal that adoption of conservation agriculture in the form of planting basins has been shown not to be related to level of education. It is shown that most farmers reached primary level of education which is a lower level from secondary and tertiary level, but however, these farmers are conversant of how to prepare planting basins. Few farmers attained secondary and tertiary level of education from all the categories, but still these farmers were familiar with the basins as those who attained primary level of education. Therefore conservation agriculture adoption is not

influenced by education and therefore the technical attributes of planting basins fit into the farming system of Chiwundura communal area as farmers can prepare the planting basins without a higher level of education.

**Household size;** Household size influences the adoption of conservation agriculture in providing labour for conservation agriculture operations. The research findings revealed that there was no marked difference for the average household size in all the categories of farmers although there were variations from household to another with household that had a bigger size likely to adopt conservation agriculture than the households that had a smaller size. It was also noted that not all the household members go to the field due to reasons such as illness and young children who cannot do the field operations.

**Land size;** The research findings show that farmers who are practicing conservation agriculture had a larger land size compared to farmers who stopped conservation agriculture and farmers who never practiced conservation agriculture. However, there was no a marked difference between the land size of the farmers who stopped practicing conservation agriculture and farmers who never practiced conservation agriculture as shown by table 3. From the information gathered, farmers who were practicing conservation agriculture and those who stopped practicing conservation agriculture highlighted that not all the land size is put under conservation agriculture. One farmer could be quoted saying,

*“My land size is big about 2 hectares and I don’t plant it all under conservation agriculture as I also practice conventional tillage.”* Another farmer could be quoted saying,

*“Although conservation agriculture is beneficial, it is labour intensive in terms of digging the basins and my land size is 2.5 ha, I only use a small portion of 0.1 ha to practice conservation agriculture”.*

Therefore given that farmers do not utilise all the area under planting basins pose a challenge to the farmers in the farming system.

Table 3: Average land size from different categories of farmers.

Categories of farmers	Average land size(ha)
Farmers practising CA	1.5
Farmers who stopped practising CA	1
Farmers who never practised CA	1.1

**Source of income;** The research findings show that all farmers were engaged in on farm activities as their source of income. Their engagement in on farm activities could partly increase conservation agriculture adoption. Most of the interviewed farmers highlighted that they do home gardening by growing vegetables such as tomatoes and carrots but however, indicated that the activities do not interfere with farm activities such as digging planting basins. Whilst

conservation agriculture adoption is influenced by on farm activities, the research findings also reveal that off farm activities can affect conservation agriculture adoption due to competing demands for labour with on farm activities. One interviewed farmer could be quoted saying,

*“I also earn my income from my work at the Midlands State University but I get more money from on farm activities and the work has an influence on adopting conservation agriculture on my piece of land.”*

Since most farmers are engaged in on farm activities, the planting basins suit into the farming system as farmers do not have competing labour demands with off farm activities.

**Crops grown;** The crops grown by farmers influence their income and therefore the possibility of influencing conservation agriculture adoption in terms of accessing money to purchase the necessary inputs for conservation agriculture. The research findings show that maize is the commonly grown crop under conservation agriculture. Information gathered from the farmers show that maize is the major crop put under conservation agriculture because it is a staple crop. One farmer could be quoted saying,

*“I grow maize under conservation agriculture because of food security reasons.”*

Whilst maize is the common crop put under conservation agriculture, the research findings also show that few farmers include groundnuts on crop rotation yet crop rotation is a principle of conservation agriculture. Therefore, the principle of crop rotation does not fit into the farming system of Chiwundura communal area because farmers are not able to include a legume crop in a rotation and cannot spend a year without growing a staple crop.

**Livestock kept;** Conservation agriculture adoption is also influenced by the availability of livestock in a household as it is a source of income to farmers and therefore farmers will have income for the purchase of inputs required under conservation agriculture. On the other hand, farmers raised the issue of livestock destroying crop residues left on the surface affecting farmers not to adopt conservation agriculture. The research findings show that farmers in Chiwundura communal area do not possess many livestock especially cattle which is used for draught power. The most common livestock kept are cattle, goats and chickens. It was noted that one farmer did not own cattle which increases farmer’s expenses in hiring animals from other farmers for draught power. One farmer could be quoted saying,

*“The other challenge is that cattle ownership is a problem such that farmers are forced to dig planting basins which are labour intensive.”*

Because the planting basins do not require draft power, they fit into the farming system and farmers can practice them without draft power.

**Ownership and technical attributes of conservation agriculture implement;** The availability of conservation agriculture equipment determines the conservation agriculture practice. Despite the fact that all farmers interviewed own a hand hoe to dig basins, the research findings show that other conservation agriculture equipment such as jab planters, rippers and direct seeders are not easily accessible in Chiwundura communal area. However, a handful of farmers

acknowledged to be familiar with rippers as a labour saving conservation agriculture equipment but expressed concern that the equipment is difficult to use as one farmer said,

*“These rippers are difficult to use as you cannot precisely space the seed and also to place manure on the furrows.”*

Because farmers were complaining about planting basins, the research findings also show that farmers highlighted the use of rippers or any other ox drawn conservation agriculture implement to ease labour operations and to maximize on the land area so as to maximize crop production. Concern was however, raised on the accessibility of these conservation agriculture equipment in terms of the costs. While some farmers highlighted that they are in a position to acquire these implements other farmers suggested that the ripper would be suitable if farmers own cattle for draft power. Despite that farmers highlighted that these implements reduce labour, some farmers raised concerns on not being able to access them due to financial constraints. One farmer was quoted saying,

*“The hand hoe is the tillage equipment which is accessible to me and I don’t think other tillage implements I can be able to afford them because of financial constraints. I cannot even ask my children to buy them for me as they also want to buy theirs so they will be overburdened in spite of the fact that these other tillage implements reduce labour.”*

Therefore in terms of costs, jab planter, rippers and direct seeders do not fit into farming system of Chiwundura communal area because most farmers are resource constrained. The technical attributes of these implements are also a challenge.

#### **4.3 Institutional support.**

**Access to extension services;** From the interviewed farmers, the institutional support given to farmers comes from the local extension workers from the Ministry of Agriculture. All the categories of farmers interviewed highlighted the presence of the extension worker in the area but however, the study also reveals that the frequency of farmers visited by extension worker varied with the category of farmers. It was noted that those farmers who never practiced conservation agriculture had limited access to extension services compared to other categories of farmers. One farmer who never practiced conservation agriculture could be quoted saying,

*“I have been trained about conservation agriculture but the extension worker does not visit me maybe because I don’t practice conservation agriculture”.*

Table 4: Number of responses of farmers to extension visits.

Cluster of farmers	Number of interviewed farmers	Frequency of extension worker visits	Number of respondents to frequency of extension worker visits
Farmers who practice CA	12	Does not visit	0
		Once a month	2
		Twice a month	9
		More than twice a month	1
Farmers who stopped practicing CA	6	Does not visit	0
		Once a month	4
		Twice a month	2
		More than twice a month	0
Farmers who never practiced CA	6	Does not visit	3
		Once a month	1
		Twice a month	2
		More than twice a month	0

As shown by table 4, more farmers highlighted that they are visited twice a month by the extension worker and also that none of the farmers highlighted that they do not get extension services from the extension worker. For farmers who stopped practicing conservation agriculture, it can be shown that they are visited once every month by the extension workers. It was also found out that the frequency of extension worker visits is less compared to the extension worker visit for farmers practicing conservation agriculture. Most farmers who never practiced conservation agriculture highlighted that they are not visited by the extension worker. Thus even for the farmers who never practiced conservation agriculture, adoption of conservation agriculture will be difficult even if they are willing because of lack of advice from extension workers.

**Training on conservation agriculture principles:** The research findings shown by figure 13 suggest that 2 farmers who never practiced conservation agriculture did not get any training on conservation agriculture principles. Data gathered reveal the tendency of extension workers not providing support to farmers who do not practice conservation agriculture. However, trained farmers highlighted that they were trained on planting basins using the hand hoe. A handful of farmers suggested that they have been also trained on tilling the land using rippers.

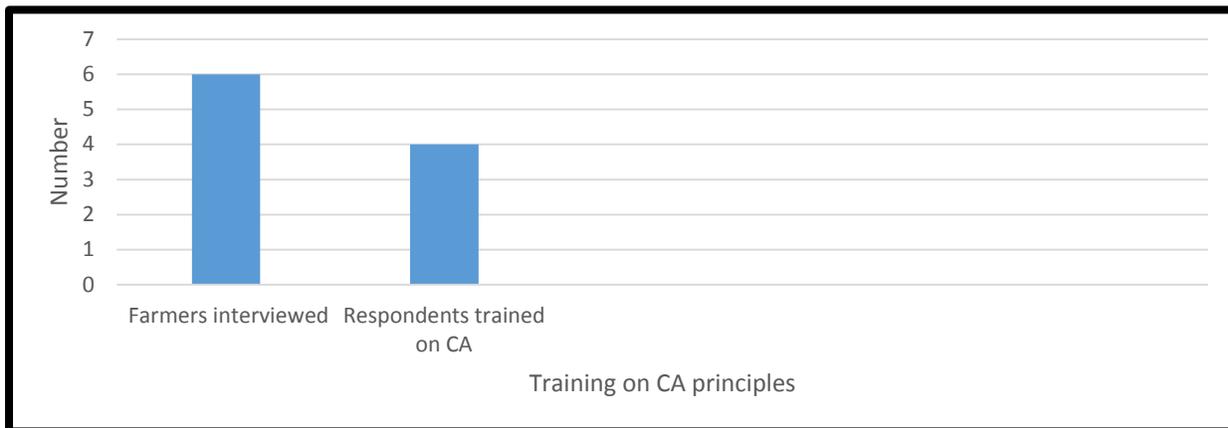


Figure 13: Number of respondents trained on conservation agriculture for farmers who never practiced conservation agriculture.

The research findings also reveal inconsistency on the part of extension workers as some farmers highlighted that they were not trained on farm management practices such as crop rotation and mulching which are principles of conservation agriculture. As shown by table 5, more farmers practicing conservation agriculture confirmed that they were trained on crop rotation and mulching compared to farmers who stopped practicing conservation agriculture and farmers who never practiced conservation agriculture. Despite farmers being trained on crop rotation and mulching it can be shown that either or both these principles are not practiced by farmers. One farmer could be quoted,

*“The extension worker visits me once a month and I have been taught on planting basins and also on management practices like crop rotation and mulching but I do not do crop rotation and mulching in my field.”*

This suggest that some farmers in Chiwundura communal area do not practice the full package of conservation agriculture because of lack of mulch and growing maize for food security reasons as highlighted by farmers. Therefore, the full package of conservation agriculture does not into the farming system of Chiwundura communal area.

Table 5: Number of respondents to training on crop rotation and mulching.

Cluster of farmers	Number of interviewed farmers	Number of respondents to training in crop rotation and mulching
Farmers practicing CA	12	8
Farmers who stopped practicing CA	6	1
Farmers who never practiced CA	6	3

#### 4.4 Source of inputs.

**Initial inputs to start conservation agriculture:** The research findings reveal that most farmers who practice conservation agriculture got their initial inputs from their own cash. These inputs are seed and fertilisers. As can be shown by table 6, it can be noted that more farmers got their inputs from own cash compared to other sources. One third of farmers interviewed highlighted that they got inputs from NGO support. It can be concluded that even without input support from NGOs there is a possibility of translating conservation agriculture successfully for farmers in Chiwundura communal area. To support this, one interviewed farmer could be quoted saying,

*“I still practice conservation agriculture despite the fact that I no longer get inputs from NGOs.”*

It can be shown also that some farmers are prepared in terms of inputs and do not entirely depend on input support from various institutions. One interviewed farmer could be quoted saying,

*“Am supported with inputs from NGOs but as a farmer I am always prepared to have my own inputs in case I don't get inputs from NGOs.”*

Table 6: Number of farmers who practice conservation agriculture to source of inputs to start conservation agriculture.

Category of farmers	Number of interviewed farmers	Source of initial inputs to start conservation agriculture	Number of respondents to source of inputs to start conservation agriculture
Farmers practising CA.	12	NGO support	4
		Bought with own cash	5
		Borrowed from friends	2
		Presidential package	1

To complement the adoption of conservation agriculture without input support from NGOs, the research findings reveal that for farmers who stopped practicing conservation agriculture, started conservation agriculture without input support from NGOs. As shown by table 7, more farmers highlighted that they started conservation agriculture by buying their own inputs. Based on this, it is crystal clear that farmers in Chiwundura communal area do not adopt conservation agriculture because of input support from NGOs.

Table 7: Number of farmers who stopped conservation agriculture to source of inputs to start conservation agriculture.

Category of farmers	Number of interviewed farmers	Source of initial inputs to start conservation agriculture	Number of respondents to source of inputs to start conservation agriculture
Farmers who stopped practicing conservation agriculture	6	Bought with own cash	5
		Borrowed inputs	1

Given that farmers highlighted that they practice conservation agriculture without input support, the recommended inputs required(table 8) for conservation agriculture pose a challenge in the

farming system of Chiwundura communal area and the high costs of inputs do not fit into the farming system of Chiwundura communal area since they are resource poor.

Table 8: Recommended input requirements under conservation agriculture.(Source: Breton, 2012).

Chiwundura communal area	Recommended Seed	Fertilisers	Organic manure
Natural region IV	Maize seed 25kg/ hectare	Compound D 80kg/hectare	4 tonnes per hectare/4scotch carts
		Ammonium nitrate 80kg/hectare	

#### 4.5 Responses for conservation agriculture.

**Responses for practicing conservation agriculture:** The research findings show that farmers who practice conservation agriculture highlighted various reasons for adopting conservation agriculture. The most common reason given by these farmers was improved crop yield for maize associated with conservation agriculture as shown by figure 14. Other reasons given were prevention of soil fertility level going down and soil conservation which however, leads to improved crop yield. Despite these farmers giving the reason of improved crop yield, concern was with increased labour associated with conservation agriculture operations. One of the farmers interviewed could be quoted saying,

*“Planting basins have a high labour in three ways which are digging the holes, manure application and weeding the field.”*

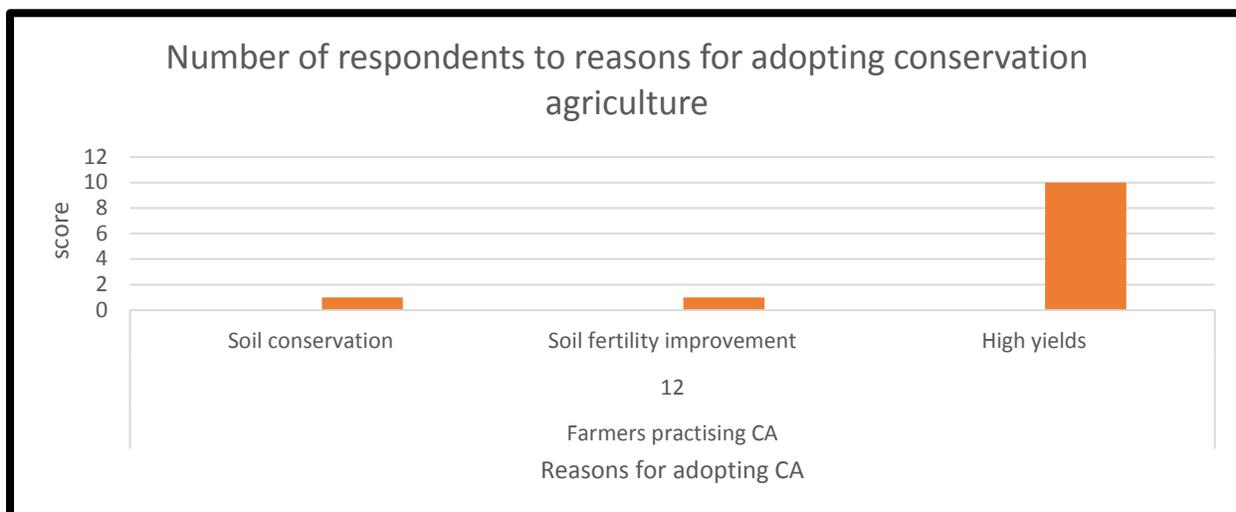


Figure 14: Number of respondents who practice conservation agriculture to reasons for practicing conservation agriculture.

When asked how much time they spend on these activities farmers indicated a double time required compared to conventional tillage and highlighted that due to the nature of the basin, the type of hoe used and intensive weed infestations. Information gathered from extension workers, planting basins require almost double the labour days compared to conventional tillage and also some costs are incurred in hiring for labour as shown by table 9. It can also be noted that some farmers form groups and help each other in their fields to spread the work load among other farmers.

Table 9: Comparison of labour days and costs associated with conservation agriculture and conventional tillage.

Planting basins	Labour days/ha	Hiring costs/ha	Total cost	Conventional tillage	Labour days/ha	Hiring costs/ha	Total
Digging basins	16	\$13	208	Ploughing and discing	7	\$75	525
Residue application	12	\$13	156	Planting	9	13	117
Planting	12	\$13	156	First weeding	12	13	156
First weeding	14	\$13	182	Second weeding	12	13	156
Second weeding	12	\$13	156				
	<b>66</b>		<b>\$ 858</b>		<b>40</b>		<b>\$ 954</b>

**Comparison of maize yield under conservation agriculture and conventional tillage;** The comparison of maize yield under conservation agriculture and conventional tillage reveal that farmers who practice conservation agriculture attain higher yield compared to farmers who practice conventional tillage as shown by figure 15. To complement these farmers who stopped and never practiced conservation agriculture appreciated that conservation agriculture lead to an improved crop yield. One farmer could be quoted saying,

*“I have stopped practicing conservation agriculture although I appreciate that conservation agriculture results in increased yield per hectare. I used to get high yields under conservation agriculture but when I practiced conventional tillage yields were not as high as those under conservation agriculture. The reason why I stopped conservation agriculture is I am the only one who is present who can go to the field as other household members are too young to go to the field therefore, I don’t have much labour that can help me to dig planting basins.”*

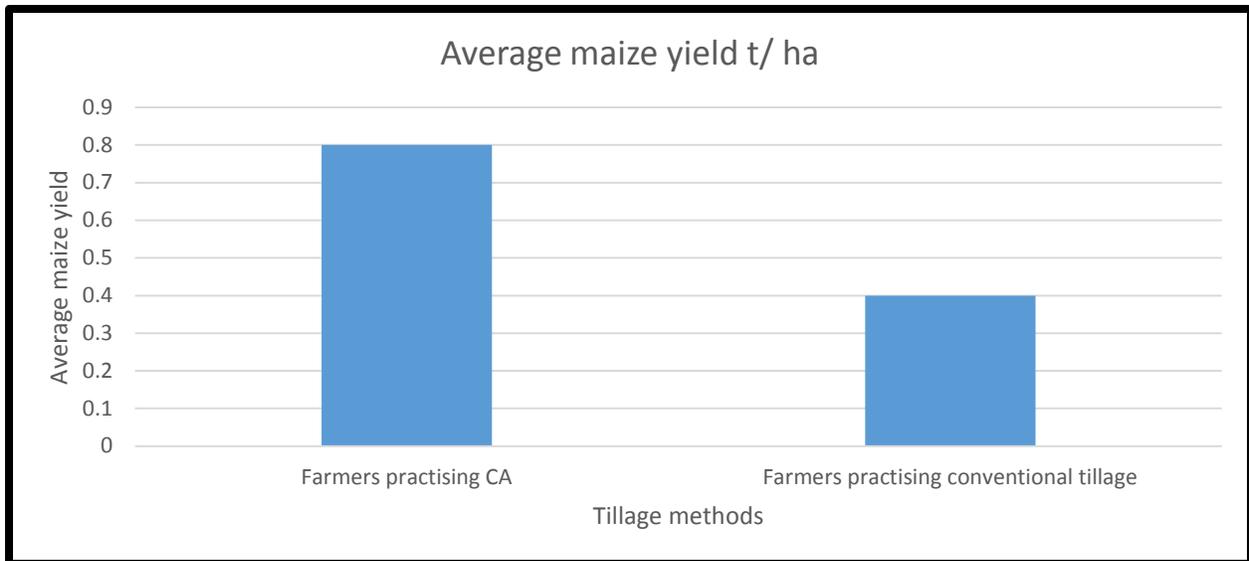


Figure 15: Comparison of average maize yield under conservation agriculture and conventional tillage.

### Responses given by farmers for stopping conservation agriculture

Farmers who stopped conservation agriculture brought forward reasons for stopping practicing conservation agriculture. Despite acknowledging that conservation agriculture leads to improved crop yield, all the respondents interviewed highlighted concerns with increased labour for digging planting basins, manuring and weeding. In addition, the research findings reveal that it is not only about increased labour required for conservation agriculture operations but also that farmers do not have the required labour force due to their household size which is limited to practice conservation agriculture operations in the field. One interviewed farmer could be quoted saying,

*“I no longer practice conservation agriculture because it is labour demanding when it comes to planting basins. I saw it difficult to continue conservation agriculture since I have 3 young children who are not very active in the field and I couldn’t afford money to hire labour to do the basins.”*

### Reasons for not practicing conservation agriculture.

The research findings show that the reasons given by the farmers for not practicing conservation agriculture is not about decreased yield as anticipated but issues related to labour. Farmers highlighted challenges to increased labour associated with planting basins and also the inadequate labour in the household due to chronic illness. Some farmers could highlight that they are failing to get people and work as a group to ease the labour required for planting basins. One farmer revealed not to have practiced conservation agriculture because it is expensive in terms of seed and fertilizer. It can therefore be concluded that these farmers are willing to adopt conservation agriculture successfully only if these challenges are solved.

#### **4.6 Other conservation agriculture bottlenecks.**

Besides the challenges experienced by farmers for digging planting basins, manuring and weeding, farmers practicing conservation agriculture and those who stopped practicing conservation agriculture highlighted other challenges they experience or experienced. Some farmers suggested the hard soil pan which paves way or increased labour for digging planting basins. When farmers were asked on the components of conservation agriculture which is expensive, farmers highlighted the expenses associated with hiring the labour and acquisition of inputs. Some farmers would pay for the labour which increases their costs. One interviewed farmer said,

*“Some challenges that I have observed with conservation agriculture is the hard soil pan which increases labour. For this reason, land preparation becomes expensive for me as I have to look for other people to dig and then pay the people for the job done.”*

A handful of farmers highlighted also the issue of low rainfall affecting their crops as the crops easily wilt. As conservation agriculture requires timeous application of inputs, some farmers expressed displeasure on the timeous arrival of inputs especially top dressing.

#### **4.7 Cultural values.**

From all the interviewed categories of farmers, conservation agriculture is a widely accepted practice in the community of Chiwundura communal area. All the respondents highlighted digging planting basins in the area is a common practice and none of the institutions deter them from practicing it. In addition, none of the respondents highlighted that crop yields are not improved without tilling the land and this provides the possibility of translating conservation agriculture successfully in the area.

#### **4.8 Findings from the extension workers (key informants).**

**Experiences on conservation agriculture;** From the interviewed extension workers for wards 10, 11 and 12, the research findings show that the extension workers in these wards have an experience on conservation agriculture as they all highlighted that they first heard about conservation agriculture when they were doing academic studies. They further on suggested that the experience was even improved when they started working for AGRITEX through practical demonstrations and trainings in the department.

**Trainings on conservation agriculture;** The research findings reveal that all the extension workers highlighted that they had been trained on conservation agriculture since joining the department. Apart from the trainings offered by the department, 2 extension workers highlighted that they got the training from NGOs like Caritas and Christian Care which collaborates with AGRITEX. However, the frequency of extension workers being trained differed from one extension to another. Regardless of the differences in trainings the extension workers revealed that they had been advised on land preparation using the planting basins, jab planters, direct

seeders and rippers but however, the extension workers highlighted that they promote planting basins in the area because everyone in the area has access to the hand hoe.

**Promotion of conservation agriculture in Chiwundura communal area;** Despite being trained on the use of jab planters, rippers and direct seeders, the extension workers highlighted that the planting basins are the most widely promoted in the area owing to lack of the other conservation agriculture implements by farmers due to cash constraints. Extension workers highlighted that they promote these conservation agriculture practices through farmer trainings, demonstrations and field days.

**Extension worker perception on conservation agriculture promoted fitting into the farming system;** Extension workers highlighted that they analyse the farming systems and also expressed concern on the increased labour associated with planting basins, crop residue destroyed by livestock and also lack of mulch which limit adoption of conservation agriculture. Despite that farmers in Chiwundura communal area are small holder farmers and considered to be resource poor such that they cannot be in a position to buy conservation agriculture implements such as jab planters, rippers and direct seeders, extension workers highlighted that farmers actually have shown a wide spread concern on these conservation agriculture implements. They highlighted that it is not about farmers not able to buy them but the equipment themselves are not readily available. For farmers who do not practice conservation agriculture due to shortage of labour, extension workers highlighted that they motivate the farmers by encouraging them to join groups to save labour in their operations on conservation agriculture.

#### **Extension workers perception on conservation agriculture.**

All the extension workers interviewed acknowledged that conservation agriculture is beneficial to the farmers and the result that the extension workers have seen is improved crop yield among the farmers who practice conservation agriculture. One extension worker was quoted saying,

*“Farmers who win at field days are the ones who practice conservation agriculture.”*

The extension worker selects farmers on the basis of improved crop yield. Maize production figures for the previous years were provided by the extension workers to complement the improved yield associated with conservation agriculture compared to conventional tillage.

#### **Extension workers perception on conservation agriculture challenges.**

The research findings from extension workers point of view revealed challenges for the widespread adoption of conservation agriculture. The issue of labour constraints associated with planting basins remains unabated and extension workers highlighted this to old age, chronic illness and migration of household members to neighbouring countries such as South Africa. Other challenges noted were the utilisation of crop residues by livestock as most farmers do not fence their fields and input challenges.

### **Extension workers view on addressing conservation agriculture challenges.**

In view of the conservation agriculture challenges hindering conservation agriculture adoption, extension workers interviewed (figure 16) expressed that if conservation agriculture has to be enhanced farmers should form groups with other farmers as a labour saving strategy. They also highlighted that conservation agriculture implements that reduce labour should be made available at an affordable prices for the farmers or farmers should form groups to buy these equipments and use them collectively. The extension worker was quoted saying,

*“It can be beneficial if farmers buy a labour saving implement and make turns to use it than to buy it as an individual which cannot be possible since most farmers are cash constrained.”*



Figure 16: Interview with extension work. Source: Author.

## **Chapter 5: Discussion.**

This section discusses the results from Chiwundura communal area and tries to compare the results with other findings and options for improving conservation agriculture in Chiwundura communal area.

### **5.1 Conservation agriculture options.**

**Conservation agriculture practice promoted in Chiwundura communal area:** Conservation agriculture in Chiwundura has been promoted in all the 3 wards in the communal area as a strategy to improve crop productivity hence food security for the small holder farmers. Mazvimavi et al., (2008) suggested that conservation agriculture does contribute to increased yields across all agro- ecological zones and thus make a major contribution to household food security. Even strong critics (Giller et al., 2009) of conservation agriculture agree that the technology works but the critical issue is whether it is the best approach given the farming system within which they operate. The increased yields from conservation agriculture when compared with conventional management practices have convinced farmers to increase the size of the area under conservation agriculture. Therefore, to improve crop production in Chiwundura communal area requires other options to improve conservation agriculture that aim to increase the hectares under conservation agriculture and to maximize on the improved yield realised from conservation agriculture.

### **Planting basins fitting into the farming system.**

As observed from the results, the common conservation agriculture promoted in Chiwundura communal area is the planting basins which are non-mechanical. This practice fits into the farming system of Chiwundura communal area because the hand hoes are cheap and suits for the resource poor farmers but however, despite this it presents some challenges which need to be looked at it critically for other options that need to be recommended. Low degree of mechanization and lack of appropriate implements have affected adoption of conservation agriculture for the small holder farmers in Sub Sahara Africa (Twomlow et al., 2008). This tends to decrease the area under conservation agriculture and in some instances farmers not adopting conservation agriculture, despite the fact that they are aware of the crop yield benefits from conservation agriculture. As was noted, the hand hoe is the most accessible equipment to farmers in Chiwundura and the technical attributes of it, is easily understood by the farmers compared to other conservation agriculture implements and in this way it fits into the farming system of Chiwundura communal area.

However, despite fitting into the farming system in terms of the costs conservation agriculture principles are not fully applied in the area. Farmers in Chiwundura communal area mostly grow maize under conservation agriculture and do not include a legume in conservation agriculture. This is consistent with the findings conducted in Zambia by IFAD (2008) which suggested that the interviewed farmers indicated that their cropping patterns were primarily determined by household food requirement and not necessarily by maximum income earning potential. However, this pose a problem to farmers by not adopting the principles of conservation agriculture which if practiced would increase crop productivity. Farmers in Chiwundura

communal area cannot grow legumes because there is no ready market for the legumes and also because maize is a staple crop in Zimbabwe it will be difficult for farmers to change their mindset to include a legume in a crop rotation. Therefore, if farmers in Chiwundura communal area have to include a legume under conservation agriculture, a strategy that allows farmers to include a legume crop under conservation agriculture and continue with the growing maize year in and year out would be of paramount importance.

Giller et al., (2009 p 25) state that “While benefits of conservation agriculture are mostly likely directly attributed to the mulch of crop residues retained in the fields, limited availability of crop residues is under many conditions an important constraint for adoption of conservation agriculture practices. On the other hand, cattle are important for the provision of draught power, milk, manure, meat and a symbol of wealth (Thornton and Herrero, 2001; Rufino et al., 2007). Despite the importance, mulch required under conservation agriculture is destroyed by cattle especially in communal areas where communal grazing occurs. This therefore brings competing demands between livestock feed and mulch required under conservation agriculture. Farmers in Chiwundura communal area prefer to let the cattle feed the crop residues because they cannot afford artificial feeds since they are resource poor. As a result mulching materials are often in critical low supply which makes the application rates of 0.5-2 tonnes per/hectare reported to be needed to increase yield unrealistic (Wezel and Path, 2002). This explains why farmers in Chiwundura communal area do not mulch under conservation agriculture. On the other hand, the crop residues have to be burnt to prevent pest and disease infestations in the field. Therefore, the full adoption of conservation agriculture principles is not possible. On the other hand, cattle act as draught power and since farmers in Chiwundura communal area own cattle, it presents an opportunity for them to use ox drawn implements such as rippers and direct seeders but however, this also depends on farmers’ ability to have the equipments since they are resource constrained. Therefore a variety of options should be provided which cater for these varying situations in Chiwundura communal area.

### **Bottlenecks of conservation agriculture.**

There are conflicting claims about labour associated with conservation agriculture. It is recognized that within the conservation agriculture community that weeds are the “Achilles heels” of conservation agriculture as weed control is often laborious and costly in the first years, with a greater requirement for herbicides than with conventional tillage at least in the first years (Wall, 2007). It is also argued that with good ground cover resulting from mulching, there is less pressure from conservation agriculture. Giller et al., (2009) argued that in manual cropping system, land preparation and weeding are very labour intensive. This is consistent with the farmers in Chiwundura communal area who expressed concern on increased labour in digging planting basins and weeding due to various socio-economic factors. This is supported by Grabowski (2011) who observed that with planting basins, adoption is constrained by increased labour requirements for land preparation and weeding. Therefore, farmers in Chiwundura communal area are constrained with labour requirements to start conservation agriculture and to cultivate larger pieces of land and other options which reduce labour requirements should be recommended.

Results shown by the study, with more females practicing conservation agriculture than males in Chiwundura communal area presents a contrasting picture from the literature. Langyintuo (2008) suggested that female farmers are less likely to adopt conservation agriculture technologies due to resource limitation and gender discrimination in extension message delivery. The adoption of conservation agriculture by females also depends with other factors. As was observed in Chiwundura communal area, more females practiced conservation agriculture because of migration by males to neighbouring countries for employment. But all the same, the issue of labour changes for men and women remain unabated and women in Chiwundura communal area face labour competing demands with household chores. Since maize is a food crop and mostly grown under conservation agriculture, females have control on the activities under conservation agriculture and it is not surprising that females do most of the activities under conservation agriculture. This presents a challenge to women because women will be doing other household chores and therefore the female headed households in Chiwundura communal area face more labour constraints compared to male headed households. Therefore, an option which caters for the female headed households with labour constraints needs to be recommended.

The issue of inputs pose a challenge for the small holder farmers as they incur more expenses in accessing the inputs especially the top dressing as Hugging and Reganold (2008) argued that conservation agriculture demand more nitrogen fertilizers to meet the nutrient requirements of the crops because the mulch that is placed allows microorganisms to utilize nitrogen in decomposing the carbon, hence there will be a need to apply more fertiliser. Even if farmers get inputs from their own cash, farmers might not be able to access the required inputs because of the high input costs. Small holder farmers are constrained with food security issues at household level due to various factors. Chiwundura communal area is a region which receives low rainfall and therefore is prone to drought hence affecting crop yield. It was not surprising that the most common reason given by farmers for practicing conservation agriculture was the increased yield under conservation agriculture, yet the yield they achieved is not enough to sustain them. This is in concordant with Giller et al., (2011) who noted the concern of decreased yield often associated with conservation agriculture if all principles of conservation agriculture principles are not practiced. It can therefore be concluded that conservation agriculture improves yield when all the principles have been applied. Although the maize yield was higher than under conventional tillage, the 0.8 tonnes per hectare achieved is less compared to other findings. For example, FAO (2011) suggest that an average crop yield of 2 tonnes per hectare for maize is achieved under conservation agriculture when early planting, frequent weeding and fertiliser application has been done. But since farmers are not practicing the complete conservation agriculture package, it was not surprising that the 0.8 tonnes per hectare was attained. This yield can also be explained by the fact that since farmers use manure in the basins, the few livestock kept cannot produce enough manure required under conservation agriculture because more volumes (4 tonnes per hectare) of manure are required to acquire the required nutrient level for maximum crop productivity. Therefore, if maximum crop productivity has to be attained it is pertinent to address the input issues in Chiwundura communal area.

Although conservation agriculture has the potential to increase crop productivity for farmers in all Zimbabwean farming sectors, many farmers are implementing incomplete conservation

agriculture package. This has reduced the benefits that farmers could derive if conservation agriculture is implemented in full (ZCATF, 2012). This is consistent with the findings from Chiwundura communal area where farmers are not fully trained on all the conservation agriculture principles by extension workers. Even the few farmers that were trained on conservation agriculture principles, farmers do not practice crop rotation including a leguminous crop because of the need for household food security requirement. It was therefore not surprising that most farmers in Chiwundura communal area do not practice the full package of conservation agriculture. This is supported by Giller et al., (2009) who suggested that farmers in Africa do not adopt all the principles of conservation agriculture for various reasons including limited access to inputs, labour constraints, or insufficient resources to grow cash crops and therefore, what farmers practice may be quite different from the ideal conservation agriculture. Therefore, it is of paramount importance to look for an option that aims to address this issue.

### **Possibility of translating conservation agriculture successfully.**

As conservation agriculture promotion is often combined with input support, the assessment of its success is difficult as it is hypothesized that farmers tend to practice conservation agriculture because of input support. On the other hand, farmers can practice conservation agriculture because of the improved crop yield benefit. Studies by Marongwe et al., (2011) found a rapid increase in the number of farmers practicing conservation agriculture in Zimbabwe despite the number of farmers practicing conservation agriculture in the absence of input support. This is because farmers would have realized the yield benefit from conservation agriculture and farmers would access their own inputs and do not entirely depend on the input support. This is consistent with the findings from Chiwundura communal area where most farmers highlighted that if there are no inputs they still practice conservation agriculture. This presents an opportunity of translating conservation agriculture successfully without input support to farmers.

Given the fact that farmers in Chiwundura communal area own cattle, it provides an opportunity for farmers to adopt other conservation agriculture options that require draught power such as rippers and direct seeders. The technical attribute of conservation agriculture equipment such as jab planters, rippers and direct seeders remain an issue for these farmers as they need to be trained. Therefore, an option which caters for these farmers on the technical attributes of the equipment is therefore required. Fanelli and Dumba (2006) noted that introducing conservation agriculture to community members requires patience, understanding, and careful explanation to convince them to adopt an alien farming practice. This is in contrast to Chiwundura communal area where the cultural values do not deter farmers practicing conservation agriculture. Therefore conservation agriculture can be translated successfully if bottlenecks are addressed.

## **Chapter 6: Conclusion and recommendations.**

This chapter presents conclusion and recommendations based on the discussion from the preceding chapter. This paper assessed the suitability of conservation agriculture practices promoted by extension workers in Chiwundura communal area by analysing conservation agriculture adoption. It also highlights interventions that can be recommended for other options in view of the challenges of conservation agriculture so as to address the issue of food security in Chiwundura communal area.

### **6.1 Conclusion.**

Conservation agriculture as it is described in literature consists of an integrated set of techniques meant to maintain soil fertility, improve water storage capacity and improved crop yield. We can observe that conservation agriculture output is so low such that it is not enough to sustain the households in Chiwundura communal area. The techniques that are essential for conservation agriculture needs to fit into sub system of farming system that is, the animal, crop and household sub subsystem to enhance adoption because various factors such as socio-economic, technical attributes and institutional factors which influence conservation agriculture adoption vary in space and therefore it is of paramount importance to analyse the farming system before intervention. In fact, there is no a general rule to adoption, but the adoption varies with the given socio economic conditions and other factors at present. This is supported by the research questions that were answered:

#### **Conservation agriculture practices being promoted to farmers by extension workers in Chiwundura communal area.**

The planting basins are the most common conservation agriculture practices promoted in Chiwundura communal area by the extension workers. The use of jab planters, rippers and direct seeders are promoted by the extension workers on a small scale. Crop rotation and mulching as principles of conservation agriculture are promoted to farmers half-heartedly by extension workers because the experiment part with farmers is lacking and as such innovation is not promoted fully.

#### **Suitability of conservation agriculture practices promoted in the farming system of Chiwundura communal area.**

The study revealed that the planting basin is considered to be the most appropriate conservation agriculture practice and therefore fits into the farming system because it is a cheap practice for the resource constrained farmers. On the other hand, other conservation agriculture practices such as the use of jab planters, rippers and direct seeders despite are promoted; albeit on a small scale do not fit into the farming system in terms of the costs as they are beyond the reach of most small holder farmers. The technical attributes of planting basins fit into the farming system as farmers showed the technical know-how of how to prepare planting basins. The technical attributes of jab planters, rippers and direct seeders, on the other hand are not known by farmers making them not suitable for farmers and therefore not fitting into the farming system. Crop rotation as a principle of conservation agriculture does not fit into the

farming system because farmers grow maize for household food requirement and do not include a legume in a rotation. Mulching under conservation agriculture is not readily available for the small holder farmers due to consumption of crop residues by livestock making the practice difficult to fit into the farming system, hence farmers do not to adopt the full package of conservation agriculture.

### **Bottlenecks of conservation agriculture in Chiwundura communal area.**

Despite planting basins fitting into the farming system, some bottlenecks were exposed such as high labour requirements in digging basins, manuring and weeding therefore hindering adoption of conservation agriculture and expansion of the area put under conservation agriculture. Therefore, it fails to extend the benefits that other forms of conservation agriculture extend to farmers. The labour shortage by the farmers is due to changes of labour between male and females, with females having competing labour demands with household chores. Women and old individuals are left to do agricultural activities due to migration of household members to neighbouring countries. Households with young children who cannot go to the field and the issue of illness also poses constraints to labour requirements. Livestock destroys crop residues which acts as mulch since cattle are left to graze openly in the communal area is a bottleneck as some farmers cannot fence their field due to limited resources. In addition, small holder farmers cannot afford artificial feeds and therefore the use of crop residues as mulch becomes a difficult practice. The high costs of inputs especially fertilisers force farmers to use organic manure which does not provide the necessary nutrient recommended under conservation agriculture and therefore the yields stay close to absolute minimum.

### **Possibilities of translating conservation agriculture successfully to small holder farmers in Chiwundura communal area.**

As was noted by Giller, et al. (2009) that there are many cases where adoption of conservation agriculture was temporary and only lasted for the course of active promotion of the technology by NGOs and research institutions but was not sustained beyond that. Given this wide thought, there is a possibility of translating conservation agriculture successfully in Chiwundura communal area as farmers have shown interest of adopting without input support from NGOs. In addition, given the fact that farmers own livestock there is a possibility for farmers to practice other conservation agriculture options that require draught power such as rippers and direct seeders. Given the fact that the practice is allowed in the community of Chiwundura communal area and that farmers do not view it as an alien practice, the adoption of conservation agriculture can be successful if interventions that aim to address the challenges are recommended.

## 6.2 Recommendations.

If conservation agriculture is to address food insecurity issues in Chiwundura communal area, the following should be recommended to AGRITEX department.

- AGRITEX to encourage formation of farmer groups to enable access of inputs through economies of scale. Farmer groups will empower farmers with high bargaining power to negotiate for input prices, transport costs, spreading the work especially for the female headed households and access to other services such as training on conservation agriculture and keep abreast to development on conservation agriculture. Farmer groups can be formed using their respective villages or wards.
- AGRITEX to encourage farmers to purchase conservation agriculture implement through formed farmer groups. This is to minimise labour requirements for the households.
- AGRITEX to provide extension workers with more information on mechanised conservation agriculture systems through training; that will enable extension workers to avail a variety of conservation agriculture options and allow farmers the final say on the option to implement depending on the socio economic of the farmers. To this end, farmers who do not own cattle for draught power will be encouraged to use the jab planter which is not labour intensive compared to using the hand hoe.
- AGRITEX to train extension workers on conservation agriculture principles and use a participatory approach with farmers to identify and develop solutions to their problems in conservation agriculture.
- AGRITEX to encourage farmers to intercrop maize with a leguminous crop, therefore acting as live mulch and providing the nitrogen nutrient required under conservation agriculture.
- Further research is required on bio physical factors affecting adoption of conservation agriculture as the study focused on socio economic, technical attributes, institutional and cultural factors.

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**Annexes.**

<b>Annexes 1: Structured questionnaire for farmers</b>			
<b>Section A: Farmer semi structured Questionnaire</b>			
<b>Questionnaire identification.</b>			
Household number.....			
Household head name.....			
Enumerator name.....			
Village.....			
Date of interview.....			
<b>Section B Household socio-economic</b>			
1) Sex of the household head			
a) Male		b) Female	
2) Level of education			
a) No education		b) Primary c) Secondary d) Tertiary	
3) Household size			
a) 1-2		b) 3-4	
c) 5-6		d) > 6	
4) Size of the land (hectares)			
a) 0.1-0.5		b) 0.6-1	
c) 1.1-2		d)>2	
5) Source of income			
a) On farm		b) off farm	
6 Crops grown			

a) Maize b) Ground nuts c) Finger millet d) Pear millet e) Other (specify)
7 Livestock kept
a) Cattle b) Goats c) Chicken d) None e) Other (specify)
8) Ownership of conservation agriculture equipment
a) Hand hoe b) Jab planter c) Rippers d) Direct seeder
<b>Section C Conservation agriculture dissemination</b>
9) Do you have an extension worker in this area?
a) Yes b) No
If yes, to which Ministry does the extension worker belong?
a) Ministry of Agriculture b) NGO c) Other (specify)
10) How frequent does an extension worker visit you in a month?
a) Doesn't visit b) Once in a month c) Twice in a month d) More than once a month
11) Have you ever heard of conservation agriculture?
a) Yes b) No
If yes to question 11, where did you hear about conservation agriculture?
a) Ministry of Agriculture Extension worker b) Fellow farmer c) NGO extension worker d) Other (specify).
12) Have you ever been trained in conservation agriculture?
a) Yes b) No
If yes, what are conservation agriculture practices that you were taught?
<b>Tillage methods</b>
a) Planting basins(hand hoe)s b) Jab planter c) Rippers d) Direct seeder
<b>Farm management practices</b>
a) Crop rotation b) mulching
13) How is conservation agriculture promoted by extension workers?
a) Demonstration b) Master Farmer Training c) Other (Specify).

<b>Section D: Level of adoption</b>
14 a) Practicing conservation agriculture b) No longer practicing conservation agriculture c) Never practiced conservation agriculture.
For response 14a and b, how did you get your initial inputs to start conservation agriculture?
a) Bought inputs with own cash      b) Input support from NGOs c) Other specify
For response 14 a, why are you practicing conservation agriculture?
a) Soil conservation b) Soil fertility improvement c) Low costs d) High yields e) Low labour demanding e) Others (specify).
What challenges have you encountered or encountering in conservation agriculture?
a) Input scarcity b) Equipment not available c) Burning of crop residues d) Destruction of residues by livestock e) Others (Specify)
Which component of conservation agriculture is more expensive?
a) Land preparation b) weed management c) Inputs d) Others (Specify)
Which farm operation is labour intensive?
a) Laying of crop residues b) Weed management c) Others (Specify)
For response 14 c, why did you stop practicing conservation agriculture?
a) Expensive    b) Labour demanding    c) Low yielding    d) Input support stopped    e) Other specify.
15) Why have you never adopted conservation agriculture?
a) Never heard of it. b) I was not selected    c) Not interested d) Expensive e) High labour demanding.    f) Others specify
16) What do you think should be done in order to promote adoption of conservation Agriculture?
a) Train more farmers b) Mount more on farm demonstration c) Hold more field days d) Conduct more farmer exchange visits f) Make conservation agriculture input available g) Promote less expensive conservation agriculture practices. h) Other (specify)
<b>Section E: Physical assets</b>
17) In your opinion which one(s) of these conservation agriculture implements is accessible to you?



## Annex 2: Checklist for extension worker(s)

### Field questionnaire

Name.....

Ward.....

Village.....

Organisation.....

Date of interview.....

When did the extension worker hear about conservation agriculture?

Has the extension worker ever been trained on conservation agriculture?

What kind of conservation agriculture practices has the extension worker been advised about?

Does the extension service analyse the farming system of farmers?

What and how extension worker promotes conservation agriculture in the area?

Are these conservation agriculture practices promoted by the extension worker to farmers working?

What methods do extension workers use to motivate farmers to try conservation agriculture?

How long has the extension worker been promoting conservation agriculture?

What kind of results that the extension worker sees for farmers adopting conservation agriculture?

What challenges does the extension worker see for the widespread adoption of conservation agriculture?

What does the extension worker think should be done to address these challenges?

What does the extension worker think needs to be done to enhance conservation agriculture adoption?

<b>Annex 3: Farmers' Responses</b>		
<b>Farmers practising CA</b>	<b>Farmers who stopped CA</b>	<b>Farmers who never practised CA</b>
<p>Interview 1 Albert Madziva</p> <ul style="list-style-type: none"> <li>• I have adopted conservation agriculture programme because it is a good programme as it has increased crop yields.</li> <li>• I use conservation agriculture for growing maize.</li> <li>• I practice planting basins on a small area.</li> <li>• I have received training from the local extension worker where the extension worker has taught me how to make planting basins.</li> <li>• The depth of the basin has to be deep enough to allow accumulation of the rain and the organic manure. I was also taught how to put manure on the basins and taught how to practice crop rotation and mulching.</li> <li>• I received 10kg of maize seed from the Presidential programme and that is the one I used for planting under conservation agriculture.</li> <li>• Even if I don't get free inputs from the Presidential package I still practice conservation agriculture.</li> <li>• Although conservation agriculture is beneficial, it is labour intensive in terms of digging the basins and my land size is 2.5 ha, I only use a small portion of 0.1 ha to practice</li> </ul>	<p>Interview 2 Miss Clara Matasa</p> <ul style="list-style-type: none"> <li>• I have stopped practicing conservation agriculture although I appreciate that conservation agriculture results in increased yield per hectare.</li> <li>• I used to get high yields under conservation agriculture but when I practiced conventional tillage yields were not as high as those under conservation agriculture.</li> <li>• The reason why I stopped conservation agriculture is I am the only one who is present who can go to the field as other household members are too young to go to the field.</li> <li>• When I practiced conservation agriculture some relatives would come and help to dig the planting basins as they have proved to be labour intensive.</li> <li>• I grow various crops which are maize, groundnuts, finger millet and cowpeas and I used to plant maize under conservation agriculture.</li> <li>• My plot size is 0.7 hectares and its quite big for planting basins.</li> <li>• I don't own livestock and rippers and that is why I used planting basins.</li> <li>• I have heard trainings on</li> </ul>	<p>Interview 8 Miss A Khumalo</p> <ul style="list-style-type: none"> <li>• I have never practiced conservation agriculture since I relocated to this place.</li> <li>• The reason behind is the land that I possess is very hard since it was never ploughed. For this reason I find it very hard to dig planting basins.</li> <li>• As a female I find it hard to dig the land alone as I stay on my own.</li> <li>• The land I was allocated is also very big which is 1 hectare.</li> <li>• I appreciate the benefits of conservation agriculture but without labour I practice the conventional tillage.</li> <li>• Despite having source of income on a farm activity I also get some money from relatives.</li> <li>• I grow maize and groundnuts on my piece of land.</li> <li>• I have heard of conservation agriculture from a fellow farmer and I was not trained about conservation agriculture.</li> <li>• I think for adoption to improve there is need to train more farmers on conservation agriculture because what we used to do in the past is now different from what is being done today.</li> <li>• The plant spacing under</li> </ul>

<p>conservation agriculture.</p> <ul style="list-style-type: none"> <li>• I depend entirely on farm activities for my income and I don't have competing demands to practice conservation agriculture.</li> <li>• Some challenges that I have observed with conservation agriculture is the hard soil pan which increases labour.</li> <li>• For this reason land preparation becomes expensive for me as I have to look for other people to dig and then pay the people for the job done.</li> <li>• I also face some problems with weed management as weeds tend to flourish more under conservation agriculture.</li> <li>• If I delay weeding my yields will be lowered. I also hire people to weed my land and pay them.</li> <li>• I only possess the hand hoe and that is the one I use to make planting basins.</li> <li>• I own cattle ,goats and chicken and the cattle cannot eat the mulch put on conservation agriculture as my plot will be fenced.</li> <li>• Am not ware of jab planters, rippers and direct seeders and even if they are introduced I don't think I will be in a position to buy them because they might be costly to me.</li> <li>• Am content with the hand hoe only</li> </ul>	<p>conservation agriculture mainly on how to dig plant basins.</p> <ul style="list-style-type: none"> <li>• Iam not affected by the withdrawal of input support as I can use retained seed to plant and still have good yield.</li> <li>• I only have a hand hoe and it is easy to use it despite its labour intensive.</li> <li>• I would appreciate if we have labour saving conservation practices and enhance my crop productivity.</li> </ul>	<p>conservation agriculture is different from the plant spacing under conventional tillage.</p> <ul style="list-style-type: none"> <li>• The hand hoe remains the implement which can be accessible to me and other tillage options am not really aware of them.</li> <li>• Iam not happy with the extension worker as he doesn't visit me probably because I don't practice conservation agriculture.</li> <li>• He only visits those farmers who are practicing conservation agriculture.</li> </ul>
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<p>the labour constraint associated with it.</p> <ul style="list-style-type: none"> <li>• I don't have an extension worker in this area and I have got much of conservation agriculture from farmer groups in the area.</li> </ul>		
<p>Interview 4 Mr Jonathan Nhubu.</p> <ul style="list-style-type: none"> <li>• Conservation agriculture in the form of planting basins has improved my maize productivity.</li> <li>• I have 2 hectares of land where I plant maize, groundnuts, sorghum, Bambara nut and cowpeas.</li> <li>• The reason why I am practicing conservation agriculture is it has increased my yields substantially to around 1 t/ha.</li> <li>• I don't mulch my fields neither do I rotate crops as I have not been advised about that.</li> <li>• Planting basins have a high labour in three ways which are digging the holes, manure application and weeding the field.</li> <li>• I work with my wife and children for digging basins and half of my land is under conservation agriculture.</li> <li>• I access inputs in two ways that is inputs from my own cash and inputs from presidential package.</li> <li>• If I don't get free inputs I always buy my own inputs and practice conservation agriculture.</li> </ul>	<p>Interview 3 Mr G Gonese</p> <ul style="list-style-type: none"> <li>• I have stopped practicing conservation agriculture on my land for the past two years.</li> <li>• The reason behind is its labour demanding when it comes to digging of planting basins.</li> <li>• Myself and my wife do the agricultural activities and sometimes I will be at work and often my wife sometimes gets ill such that she cannot go to the field.</li> <li>• I have been taught by extension workers on how to prepare planting basins using the hand hoe.</li> <li>• I was not taught about crop rotation and mulching by extension workers.</li> <li>• The extension worker has promoted the planting basins by demonstration and I was really satisfied by the way the extension worker has taught me.</li> <li>• I also earn my income from my work at the Midlands State University but I get more money from on farm activities and the work has competing labour</li> </ul>	<p>Interview 11 Emely Dema</p> <ul style="list-style-type: none"> <li>• I have never practiced conservation agriculture because I failed to get people who were willing to form cooperatives so that we help each other out to dig basins.</li> <li>• We are 5 members in the household and 3 go to the field. I have 1 hectares of land and I depend on on farm activities.</li> <li>• I practice conventional tillage but conservation agriculture brings better yields as observed from others who practice it.</li> <li>• The other challenge is that cattle ownership is a problem such that farmers are forced to dig planting basins.</li> </ul>

	<p>demands with digging basins.</p> <ul style="list-style-type: none"> <li>• I used to practice conservation agriculture on maize crop only and the yields have been satisfactory.</li> <li>• I currently own a hand hoe for digging planting basins but I would prefer ox drawn implements such as rippers since I have cattle to reduce labour.</li> <li>• Another option to reduce labour associated with planting basins is to form more groups of people that help each other.</li> <li>• Inputs should also be accessed in time to allow early sowing which is associated with planting basins.</li> </ul>	
<p>Interview 7 Sheperd Muzona</p> <ul style="list-style-type: none"> <li>• I have benefited from conservation agriculture as it has given me high yields from piece of land of one hectare.</li> <li>• We are only 2 in the household with my wife who help me in the fields with labour.</li> <li>• My source of income comes from on farm activities and I grow maize under conservation agriculture.</li> <li>• I also grow ground nuts and Bambara nut. I don't own cattle but I only have chickens.</li> <li>• I use hand hoes to dig planting basins in my field.</li> <li>• I have been trained about conservation agriculture about</li> </ul>	<p>Interview 5 Evelyn Jayaguru</p> <ul style="list-style-type: none"> <li>• I stopped practicing conservation agriculture although it brings benefits to improve crop productivity.</li> <li>• I used to dig planting basins and as a female with few household members I faced labour challenges.</li> <li>• We are 3 members in the household and the other 2 members cannot go to the field. I entirely depend on on farm activities for my source of income.</li> <li>• My land is not big enough but still when it comes to digging planting basins I faced these challenges of labour constraints.</li> </ul>	<p>Interview 14 Thandiwe Simba</p> <ul style="list-style-type: none"> <li>• I have never practiced conservation agriculture because it is high labour demanding. I am a female and we are just 2 people who can go to the field and the son will be herding cattle and sometimes I will be alone.</li> <li>• I have been trained all the components of conservation agriculture tillage methods, crop rotation and mulching but the extension worker hasn't visited me for some time.</li> <li>• I think for adoption to improve farmers should get into groups and operations of activities would be spread and also inputs should also be easily accessible.</li> </ul>

<p>planting basins and mulching by the local extension worker although he has never visited me for some time .</p> <ul style="list-style-type: none"> <li>• The planting basins are promoted by demonstration.</li> <li>• I acquired inputs from my own cash and input support from the local NGO and even if I don't get free input support I will always practice conservation agriculture.</li> <li>• I have also faced challenges under conservation agriculture such as lack of early rainfall required by the planting basins.</li> <li>• The crop residues are not destroyed by livestock as I always fence my field to avoid cattle entrance.</li> <li>• For people to adopt conservation agriculture there should be more trainings to farmers.</li> <li>• Currently the hand hoe is the only equipment that I use and it is easy to use despite the labour intensive associated with it.</li> <li>• If other tillage options are promoted I am in a position to buy them as long there is not much labour associated with them.</li> <li>• It also means that I have to own a herd of cattle to mount the implements.</li> <li>• Some community members discourage me to use planting</li> </ul>	<ul style="list-style-type: none"> <li>• I used planting basins on maize. I also keep few cattle and chickens.</li> <li>• I have been trained on conservation agriculture by the local extension worker who is from the Ministry of Agriculture but he visits me once per month not as frequent as I thought it should be.</li> <li>• I have been trained how to dig planting basins particularly the planting depth and also how to apply manure in these planting basins through demonstration by the extension worker.</li> <li>• When I was practicing conservation agriculture, I used to buy my own inputs and never waited to get them for free from various organisations such as NGOs.</li> <li>• Besides labour demanding associated with digging planting basins, it also requires more time for digging which also competes with other households chores.</li> <li>• To promote adoption of conservation agriculture, I think less laborious conservation agriculture practices should be promoted.</li> <li>• The hand hoe which I used to dig planting basins is easily accessible to me as it is not expensive. \</li> <li>• Other conservation agriculture tillage options such as jab planters, rippers and direct seeders can be</li> </ul>	<ul style="list-style-type: none"> <li>• The use of rippers can be a better option to reduce labour associated with planting basins.</li> </ul>
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<p>basins because they want to make money through hiring of cattle for ox drawn implements.</p>	<p>expensive and I don't think I will be in a position to acquire them.</p>	
<p>Interview 9 Monica Ncube</p> <ul style="list-style-type: none"> <li>• Conservation agriculture is a programme which has really helped me to achieve good yields.</li> <li>• I have been practicing conservation agriculture for the last 4 years and I have never went wrong.</li> <li>• The reason behind for practicing conservation agriculture is it retains water and therefore leads to higher yields.</li> <li>• My husband passed away and have 2 other members in the household to help me and my land size is big about 2 hectares and I don't plant it all under conservation agriculture due to shortage of labour.</li> <li>• I grow maize, groundnuts, cowpeas and Bambara nut and maize is grown under conservation agriculture.</li> <li>• This piece of land is the source of my income so I have to apply best practices to achieve good yields.</li> <li>• I don't use mulch under conservation agriculture so I don't have problems with cattle destroying crop residues.</li> <li>• I am happy with the extension worker as he frequently visits me.</li> </ul>	<p>Interview 6 Lovemore Nyika</p> <ul style="list-style-type: none"> <li>• The ill health and also that I have children who go to school has negatively impacted on the labour availability in my household and it is the reason why I stopped conservation agriculture but however yields brought about digging planting basins is better compared when practicing conventional tillage.</li> <li>• My household size is less as we are 3 members of the household and obviously there is shortage of labour.</li> <li>• I also have a big land size which makes it impossible to continue with digging planting basins.</li> <li>• I depend on source of income from on farm activities and I grow a variety of crops which are maize, groundnuts and Bambara nut.</li> <li>• I also own a few herd of cattle. I own a hand hoe that I used to make planting basins. I have heard of conservation agriculture from the local extension worker who is from the Ministry of Agriculture and has promoted it through demonstrations.</li> <li>• I was taught that a planting basing should have a deep hole for</li> </ul>	<p>Interview 15 Sophia Chimani</p> <ul style="list-style-type: none"> <li>• Despite the fact that I have been trained on conservation agriculture, I have never adopted conservation agriculture because of high labour demanding.</li> <li>• Digging planting basins need a lot of work in spite of the fact that we are 5 who go to the field</li> <li>• I practice conventional tillage and I have not had got good yields but some farmers say conservation agriculture brings better yields.</li> <li>• The issue of inputs also limits me to practice conservation agriculture.</li> <li>• The issue of labour associated with planting basins can be solved by farmers forming cooperatives.</li> <li>• I have never heard of other tillage methods implements but if they save labour am able to use them.</li> </ul>

<p>Normally he visits me twice a month.</p> <ul style="list-style-type: none"> <li>• I have understood the demonstrations about digging planting basins and also how to apply clay from an anthill and also fertilisers in the basin.</li> <li>• I was not taught about crop rotation and mulching. I got the inputs from local NGO which is CARE and even if I don't get free inputs, I still practice conservation agriculture.</li> <li>• Despite the benefits under conservation agriculture I have met also some challenges like the hard soil pan which becomes laborious to dig planting basins.</li> <li>• This can be solved by formation of groups to help each other.</li> <li>• The issue of inputs is also a challenge as the inputs are expensive.</li> <li>• To improve adoption I think there should be more on farm demonstration.</li> <li>• I use hand hoes for digging planting basins but I have also heard of rippers which can be alternative to use for conservation agriculture.</li> <li>• These rippers are difficult to use as you cannot precisely space the seed and also to place manure on the furrows.</li> </ul>	<p>holding water.</p> <ul style="list-style-type: none"> <li>• I was never taught about crop rotation and mulching.</li> <li>• The frequency of the extension worker visiting me is not frequent as he visits me once every month.</li> <li>• When I was practicing conservation agriculture I used to buy my own inputs which are expensive.</li> <li>• When I was practicing conservation agriculture I also encountered challenges such as lack of fertilizer.</li> <li>• Although I used manure to feed the soil I was also taught that I should also use artificial fertilizers to increase crop productivity.</li> <li>• The seed was also a challenge.</li> <li>• The hand hoe is easily accessible to me and it is easy to use.</li> <li>• It is a challenge to me when the hoe is big as I have to use more power to dig the planting basins.</li> <li>• If other conservation agriculture options which reduce labour I would use them but however that will depend on how easy are they to use and also the cost associated with them in terms of buying them.</li> </ul>	
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<ul style="list-style-type: none"> <li>Besides these rippers can be expensive for an individual to buy it so I think if farmers form groups and buy the rippers as a group.</li> </ul>		
<p>Interview 10 Ben Teswa.</p> <ul style="list-style-type: none"> <li>I practice conservation agriculture in my land because it allows early planting an improved water retention which leads to higher yields.</li> <li>I grow maize crop under conservation agriculture for food security reasons.</li> <li>We are 6 people in the household and 3 people work in the field.</li> <li>I have 1.5 hectares of land but I practice conservation agriculture on 0.5 hectares.</li> <li>I entirely depend on on farm activities for the source of income and I also do gardening where I grow vegetables and tomatoes.</li> <li>The gardening does not compete with labour with conservation agriculture.</li> <li>I practice planting basins and it is labour intensive though.</li> <li>The challenge of labour is spread among members of the household and we dig basins slowly until all planting basins are finished.</li> <li>The extension worker visits me once a month and I have been</li> </ul>	<p>Interview 20 Emeldah Dinga</p> <ul style="list-style-type: none"> <li>I no longer practice conservation agriculture because it is labour demanding when it comes to planting basins.</li> <li>I saw it difficult to continue conservation agriculture since I have 3 young children and I couldn't afford money to hire labour to do the basins.</li> <li>I have almost a hectare of land and I depend on on farm activities.</li> <li>I used to grow maize under conservation agriculture. I was taught on planting basins, rippers and farm management practices such as crop rotation and mulching and the extension worker visits me twice a month.</li> <li>I used to buy my own inputs for conservation agriculture.</li> <li>I also faced the challenges such as inaccessibility to inputs such as seed and fertilizer and also digging of planting basins and manuring when it comes to labour.</li> <li>I think there should be more trainings and mount more on farm demonstrations.</li> </ul>	<p>Interview 16 Abednigo Pamire</p> <ul style="list-style-type: none"> <li>Manpower is not enough and also my children are young to go the field are the reasons I have never adopted conservation agriculture as I have a big land which is over 2 hectares.</li> <li>I have seen some other farmers who did practice conservation agriculture who got better yields.</li> <li>I depend on on farm activities for my source of income but when it is not the time for planting, I normally do peace jobs. I have been trained about conservation agriculture but the extension worker doesn't visit me maybe because I don't practice conservation agriculture.</li> <li>To improve adoption I think more on farm demonstrations should be mounted so that people see the benefits.</li> <li>Inputs should also come in time.</li> <li>The hand hoe is easily accessible to me but other conservation tillage equipment like rippers are easier to use because two people can do the land preparation.</li> </ul>

<p>taught on planting basins and also on management practices like crop rotation and mulching but I don't do crop rotation and mulching.</p> <ul style="list-style-type: none"> <li>• Ammonium nitrate is expensive and that is a challenge that I have come across but normally I save the money for the fertilizer.</li> <li>• In this area, for improved adoption I think farmers should come together and form cooperatives for digging the basins, manuring and weed management.</li> <li>• Government should also provide inputs in time and I have used retained seed because inputs don't come in time since conservation agriculture is associated with early planting.</li> <li>• I have heard of the ripper as a tillage implement which can be used to replace hand hoe and since I have cattle it is going to be easy if I use it but the challenge is its not accessible to me.</li> </ul>	<ul style="list-style-type: none"> <li>• The hand hoe is the tillage method which is accessible to me and I don't think other tillage implements, I can be able to afford them because of financial constraints.</li> <li>• I cannot even ask my children to buy them for me as they also want to buy theirs so they will be overburdened in spite of the fact that these other tillage implements reduce labour.</li> </ul>	
<p>Interview 12 Esther Dipha.</p> <ul style="list-style-type: none"> <li>• I have practiced conservation agriculture for a long time and I am still using it.</li> <li>• It has brought good yields about 0.9t/ha. Despite the benefit I have also experienced some challenges such as inputs being expensive.</li> <li>• Sometimes rainfall can be very</li> </ul>	<p>Interview 23 Jennifer Sigodho</p> <ul style="list-style-type: none"> <li>• I have stopped conservation agriculture because of the challenges such as lack of seed and fertilizer, digging of planting basins and also problems about cattle feeding the crop residues.</li> <li>• I also faced challenges such as weeding which is difficult. I have</li> </ul>	<p>Interview 21 Agness Dzivakwe</p> <ul style="list-style-type: none"> <li>• I could not access seed and fertilizer is the reason why I have never adopted conservation agriculture.</li> <li>• I have never been trained on conservation agriculture although there is an extension worker in the area.</li> </ul>

<p>low and crops can be affected. I also face challenges on weed management as weeds thrive very well and the land has to be frequently weeded.</p> <ul style="list-style-type: none"> <li>• Am happy with the extension support I get as the extension worker frequently visits me.</li> <li>• I have been taught all the components of conservation agriculture that is tillage methods, crop rotation and mulching.</li> <li>• I practice conservation agriculture on both maize and groundnuts because of moisture retention.</li> <li>• I depend on on farm activities for the source of income.</li> <li>• I am involved in a cooperative garden where I grow vegetables, tomatoes and this does not compete with labour required for practicing conservation agriculture. Cattle cannot eat the crop residues under conservation agriculture as I fence my field.</li> <li>• I own a hand hoe and a ripper as implements for conservation agriculture but I prefer to use hand hoe compared to a ripper because ripper needs more people and also the necessary draft power.</li> <li>• With hand hoe you cannot delay planting.</li> <li>• I normally get assistance from donor support but sometimes as a farmer I am always prepared to</li> </ul>	<p>many people who go to the field but still its labour intensive.</p> <ul style="list-style-type: none"> <li>• I have about 2 hectares of land and I depend on on farm activities.</li> <li>• I grow maize on planting basins because of food security.</li> <li>• I can't grow other crops under basins but maize provides me with better yields.</li> <li>• My extension worker visits me frequently and I have been trained on planting basins and crop rotation.</li> <li>• I normally buy my own inputs with my own cash but if I don't have money I use retained seed.</li> <li>• Farmers should be trained more, mount more demonstrations and inputs should be made available to a place where they are supposed to be.</li> <li>• Despite that I use the hand hoe for conservation agriculture, I feel a ripper will do and if accessible in the shops I can buy it .</li> </ul>	<ul style="list-style-type: none"> <li>• I do conventional tillage although conservation agriculture seem to achieve better yields. I have heard of the other tillage implements but they are not accessible but given the opportunity I would use them.</li> </ul>
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<p>have inputs.</p> <ul style="list-style-type: none"> <li>• Even if I don't get input support from donors I still practice conservation agriculture.</li> </ul>		
<p>Interview 13 Joyce Mutodza</p> <ul style="list-style-type: none"> <li>• Conservation agriculture brings high yields if only rainfall is good.</li> <li>• I practice conservation agriculture because of better yields associated with it although sometimes I face some challenges such as land preparation, fertilizer scarcity and poor rainfall.</li> <li>• I practice planting basins on maize for food security reasons.</li> <li>• I have almost a hectare of land and I have a portion where I dig planting basins as I cannot have all the basins for one hectare.</li> <li>• I also have garden at my homestead for growing vegetables and it's a source of income.</li> <li>• I sometimes get inputs from government input support programs and sometimes I use my own inputs. I have been taught about planting basins and crop rotation by extension worker and am happy that he visits me frequently.</li> <li>• The cattle cannot eat the crop residues because of fencing.</li> <li>• The hand hoe remains practicable to me and other tillage implements</li> </ul>		

<p>like rippers and direct seeders are only practical if one has draft power.</p>		
<p>Interview 17 Enety Banda</p> <ul style="list-style-type: none"> <li>• Conservation agriculture in the form of planting basins leads to high yields.</li> <li>• If I put more area under conservation agriculture it gives me more crop production compared to conventional tillage method.</li> <li>• Conservation agriculture also does not lead to soil erosion.</li> <li>• I didn't get better yields the previous season because of low rains. We are 5 people who work in the fields and I have more than 2 hectares of land.</li> <li>• I get my income entirely on on farm activities and I practice conservation agriculture on maize crop because of food security.</li> <li>• The extension worker visits me regularly and I have been taught on crop rotation and planting basins through demonstrations.</li> <li>• Sometimes I buy inputs and some of the times I am supported with inputs from NGO and from the government.</li> <li>• I face challenges in input scarcity especially top dressing despite that I put manure in the field.</li> <li>• Digging planting basins and weed</li> </ul>		

<p>management is also a challenge especially if children are not around these operations become difficult.</p> <ul style="list-style-type: none"> <li>• For scaling up more fertilizers should be made available.</li> <li>• Although I use the hand hoe for digging the basins, I think rippers are a better option because they would increase the area and also save labour.</li> </ul>		
<p>Interview 18 Maudy Dhlamini</p> <ul style="list-style-type: none"> <li>• Conservation agriculture retain water if there is little rainfall and because of this I get better yields.</li> <li>• The extension worker visits me regularly because of conservation agriculture that I practice and I have been taught all the components of conservation agriculture.</li> <li>• I do gardening and does not affect myself in practicing conservation agriculture.</li> <li>• Even without input support I still make planting basins. If you do not practice conservation agriculture properly as in covering the planting basins with soil, germination of the seed might not occur.</li> <li>• I also have problems with weed management as frequent weeding is necessary and I think forming cooperatives would help.</li> </ul>		

<ul style="list-style-type: none"> <li>• More clubs should also be formed and farmers buy inputs as a group and inputs become cheap.</li> </ul>		
<p>Interview 22 Ruth Magaya</p> <ul style="list-style-type: none"> <li>• Conservation agriculture in the form of planting basins is hard but the small area I plant gives me better yields and that is the reason why I am practicing it.</li> <li>• I depend on on farm activities although sometimes relatives give me support. I also keep livestock such as cattle and goats and the livestock cannot eat the crop residues placed on the planting basins because I fence the field.</li> <li>• I have been trained on conservation agriculture from the local extension worker and the extension worker visits me when preparing the land, manuring and weeding.</li> <li>• Other challenges such as labour intensive, expensive fertilizers and frequent weeding are common.</li> <li>• I plant late because the extension worker doesn't give me the inputs in time.</li> <li>• To improve adoption there should be more trainings and holding more field days.</li> <li>• The hand hoe is the tillage implement which is accessible to me.</li> </ul>		

<ul style="list-style-type: none"> <li>• I have heard of ripper but I have not used it but I have been taught how to use it but the technical attributes of it is difficult to understand.</li> </ul>		
<p>Interview 24 Miriam Mungwara</p> <ul style="list-style-type: none"> <li>• When I dig planting basins there is no soil erosion and water retention is increased which leads to higher yield hence the reasons why I practice conservation agriculture.</li> <li>• Despite the fact that I practice conservation agriculture I have met some challenges like late accessibility of fertilizers and seeds, and labour intensive in farm operations.</li> <li>• Sometimes I hire people to help me. I also ask friends to help me. I dig planting basins when sowing maize as it is the staple food.</li> <li>• I get my money from on farm activities and I own livestock as well .</li> <li>• The local extension worker visits me for conservation agriculture and I have been trained on planting basins and rippers.</li> <li>• I have also been taught about crop rotation which is a component of conservation agriculture.</li> <li>• Lack of inputs make me borrow the inputs from neighbours.</li> <li>• I think rippers are better than hand</li> </ul>		

<p>hoes. The problem is I don't have money to buy the ripper but otherwise I can be able to use the rippers.</p>		
<p>Interview 19 Catherine Mpofu</p> <ul style="list-style-type: none"> <li>• I get money from conservation agriculture through planting basins.</li> <li>• I achieve high yields out of it. We are 3 people who go to the field.</li> <li>• I get money from on farm activities.</li> <li>• I use the hand hoe to dig plant basins and I have been taught how to make planting basins together with plant spacing and planting depth.</li> <li>• I was also taught crop rotation and mulching through demonstration. The extension worker visits me regularly to check on my field.</li> <li>• I still practice conservation agriculture despite the fact that I no longer get free inputs from NGOs.</li> <li>• Germination can be a problem especially if rains are little and also the issue of inputs.</li> <li>• To improve adoption there should be more demonstrations on conservation agriculture and farmers should visit people who have achieved good yields to see how they do it.</li> <li>• The hand hoe remain the only conservation agriculture accessible to me though I have heard of</li> </ul>		

rippers which seem to be a better option than the hand hoe in terms of reducing labour.		
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Annex 4 Extension worker responses	Responses by extension worker 1	Responses by extension worker 2	Responses by extension worker 3
Questions			
When did the extension worker hear about conservation agriculture	<ul style="list-style-type: none"> <li>In 2006 at agricultural college</li> </ul>	<ul style="list-style-type: none"> <li>During attachment in 2006 in Gangira ward 12.</li> </ul>	<ul style="list-style-type: none"> <li>In 2002 at agricultural college.</li> </ul>
Has the extension worker ever been trained on conservation agriculture?	<ul style="list-style-type: none"> <li>Yes, trained at AGRITEX department and training from NGO(CARITAS)</li> </ul>	<ul style="list-style-type: none"> <li>Trained by AGRITEX department, CARITAS and CARE.</li> </ul>	<ul style="list-style-type: none"> <li>Trained four times at AGRITEX department.</li> </ul>
What kind of conservation agriculture practices has the extension worker been advised about?	<ul style="list-style-type: none"> <li>Making of planting basins, the use of job planters, direct seeders and rippers</li> </ul>	<ul style="list-style-type: none"> <li>Making of planting basins, rippers, direct seeders and job planter.</li> </ul>	<ul style="list-style-type: none"> <li>Trained on land preparation, spacing, manure, fertiliser application and mulching.</li> <li>Trained also on hand hoe, rippers and job planters.</li> </ul>
Does the extension service analyse the farming system of farmers?	<ul style="list-style-type: none"> <li>Yes, Most farmers are resource poor, hence the hand hoes suits the farming system in terms of costs.</li> <li>Some farmers have shown interest on job planters, direct seeder and rippers.</li> </ul>	<ul style="list-style-type: none"> <li>Yes, farmers here have a more or less similar characteristics in terms of socio economic status and the hand hoe suits them since everybody can own it.</li> <li>Some farmers in this farming system can be able to buy rippers and for this reason I give technical advice on them</li> </ul>	<ul style="list-style-type: none"> <li>Yes, farmers cannot mulch the land because they also need to feed their cattle.</li> <li>Farmers cannot rotate with legumes because they are not motivated to grow legumes which do not have market.</li> <li>Although the hand hoe fits in the farming system some farmers are in a position to buy rippers and direct</li> </ul>

			seeders.
What and how extension worker promotes conservation agriculture in the area?	<ul style="list-style-type: none"> <li>Planting basins are widely promoted compared to job planter, direct seeder and rippers and this is done through demonstration plots and field days.</li> </ul>	<ul style="list-style-type: none"> <li>Planting basins, job planters and rippers through demonstration to the farmer groups.</li> </ul>	<ul style="list-style-type: none"> <li>Planting basin is the most promoted practise.</li> <li>I tell farmers the benefits of conservation agriculture through farmer trainings, farmer groups, agricultural shows, field days and demonstration.</li> </ul>
How long has the extension worker been promoting conservation agriculture?	<ul style="list-style-type: none"> <li>Since 2007</li> </ul>	<ul style="list-style-type: none"> <li>Since 2007</li> </ul>	<ul style="list-style-type: none"> <li>Since 2004</li> </ul>
Are these conservation agriculture practices promoted by the extension worker to farmers working?	<ul style="list-style-type: none"> <li>Basins and rippers are working properly to the farmers.</li> </ul>	<ul style="list-style-type: none"> <li>Planting basins are working despite that most farmers do not practice mulching.</li> </ul>	<ul style="list-style-type: none"> <li>Yes it is working, conservation agriculture yield more than conventional agriculture.</li> </ul>
What methods do extension workers use to motivate farmers to try conservation agriculture?	<ul style="list-style-type: none"> <li>Encouraging farmers to form social groups to ease out labour intensive operations.</li> </ul>	<ul style="list-style-type: none"> <li>Training awareness</li> </ul>	<ul style="list-style-type: none"> <li>To join groups to save labour</li> </ul>
What kind of results that the extension worker sees for farmers adopting conservation agriculture?	<ul style="list-style-type: none"> <li>Farmers who practise conservation agriculture achieve high yields and these are the farmers who win at field days.</li> </ul>	<ul style="list-style-type: none"> <li>Improved yield for farmers.</li> </ul>	<ul style="list-style-type: none"> <li>Food security, most farmers who practice conservation agriculture attain higher yields.</li> </ul>
What challenges does the extension worker see for the widespread adoption of	<ul style="list-style-type: none"> <li>Lack of mulch</li> <li>Late of availability of rainfall.</li> </ul>	<ul style="list-style-type: none"> <li>Basins are labour intensive because of old age.</li> </ul>	<ul style="list-style-type: none"> <li>Lack of inputs, mulch, rippers, jab planters and direct seeders.</li> </ul>

conservation agriculture?	<ul style="list-style-type: none"> <li>• High cost of fertilisers</li> </ul>	<ul style="list-style-type: none"> <li>• Mulch is not readily available</li> </ul>	<ul style="list-style-type: none"> <li>• HIV AIDS affecting the availability of labour.</li> <li>• Migration to other neighbouring countries.</li> </ul>
What does the extension worker think should be done to address these challenges?	<ul style="list-style-type: none"> <li>• Fertilisers should be at an affordable price. For example a 50 kg bag of Compound D costs \$40 which is beyond the reach of the farmers.</li> </ul>	<ul style="list-style-type: none"> <li>• Live mulch is ideal.</li> <li>• Farmers should form groups.</li> <li>• Government should make available of better equipments.</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable implements should be made available to reduce labour.</li> </ul>
What does the extension worker think needs to be done to enhance conservation agriculture adoption?		<ul style="list-style-type: none"> <li>• More trips to other farmers who would have successfully applied conservation agriculture.</li> </ul>	<ul style="list-style-type: none"> <li>• Provide more equipments.</li> <li>• Promote more field days to motivate farmers.</li> </ul>