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RESEARCH TITLE

Food security through Conservation Agriculture (CA): Opportunities, Prospects and Challenges for Gokwe South District in Zimbabwe.

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Title

Food security through Conservation Agriculture (CA) in Zimbabwe: Opportunities, Prospects and Challenges for Gokwe South District

Abstract

Food is basic human need. Without food, human body fails to function normally. Yet, globally food insecurity is a problem. The severity of the problem varies from one continent to the other as well as from one country to the other. Generally food shortages are more intense in developing counties than in developed countries. Reasons for these variations are many and diverse; they include level of technology used in production, processing and storage of food. Food production policies may either support or stifle food productivity.

The study was centred on three fundamental objectives. The first one was to identify attributes of food insecurity in Gokwe South district. The second one was to highlight the opportunities and challenges of CA technology on food security in the district. The last objective was to assess CA attribution to food security in Gokwe South district.

CA is a farming system or practice which aims to conserve soil, labour and water by using blanket cover (mulch) to minimise runoff and improve the conditions for plant establishment and growth. This practice includes various mechanisms like use of hand hoes for basin formation, jab-planter, animal drawn direct seeder, animal drawn ripper and motorised equipment like tractor mounted direct seeder, tractor mounted sub-soiler and multi row tractor mounted direct seeder.

Survey results indicated that although CA contributes significantly to household food security, ‘as a best practice’ but it’s not a ‘best fit’ practice since results fluctuates from one area to the other. Introduction of CA in Zimbabwe was input driven supported mostly by non-governmental organisations hence sustainability of the concept is highly questionable. The results revealed that CA is more of a farming system than technology and its key principles are not of equal eminence and farmers are practising CA at a small scale citing labour constraints. Markets play a crucial role in attainment of sustainable food security.

Key Words: Conservation agriculture, Food Security, Sustainable Livelihoods Approach and sustainable intensification

1.0 Introduction

Food shortage is one of the major problems worldwide. Food is basic human need. Without food, human body fails to function normally. The United Nations Food and Agriculture Organisation (FAO) estimates that about 870 million people (12.5% of the global population) in the world are food insecure or one in eight people in the world were suffering from chronic undernourishment between 2012 and 2013. About 852 million people, which constitutes 98% of the world`s hungry people live in developing countries. It is important to note that 852 million people represent 15% of the population of developing countries, (FAO 2012).

Measured on a worldwide scale, the average yield of major crops has increased steadily for the past five decades, according to FAO 2012, yet production levels have been unequal across the world and the current yield gap tends to be the widest in the poorer regions, for instance, in developing nations, affecting mostly less resource-endowed farmers at any given location (Tittonell and Giller, 2013). Yield gap is commonly defined as the difference between the potential and the existing crop yield levels which is wide for major crops worldwide (Tittonell, 2014).

Developed countries, for instance, in Europe and America, are more food secure than Africa and Latin America. Reasons for these variations are many and diverse; they include the level of technology used in production and processing and storage of food. Food production policies may either support or stifle food productivity. The advent shift from food cropping to cash cropping is one of the factors affecting food availability, for instance, tobacco and cotton production at the expense of cereals like maize, millet and sorghum has resulted in food

shortages in Swaziland where sugarcane production was highly promoted (Terry and Ryder 2007, 2005).

Heavy irrigation equipment in agriculture gives developed countries a comparative advantage in the agricultural spectrum, for instance, France, Greece, Italy, Portugal and Spain account for 12 million hectares, corresponding to 75% of the total area under irrigation within European Union (Wriedt et al. 2008). Areas under irrigation in Europe are highly prolific according to statistical productivity surveys (Portmann et al. 2008; Hoogeveen et al. 2003). Technology is also an issue in food security, especially in boosting production, for example, conservation agriculture (CA) is an environmentally friendly farming system which aims to increase yield production. CA is characterized by three major principles, which are; continuous minimum mechanical soil disturbance, permanent organic soil cover and crop rotation.

According to Tittonell (2014) food insecurity in developing nations is mainly caused by factors which are:

i. Inadequate models of agricultural development, exacerbated by increasing population densities in rural areas leading to severe degradation of the natural resources;
ii. Poor small scale farmers in developing nations do not have access, cannot afford or are unwilling to adopt 'modern' agricultural technologies;
iii. Some technologies were not developed to fit the reality of smallholder systems and hence they are ineffective at increasing crop and livestock productivity;

Food insecurity refers to a situation where one cannot access adequate and nutritious food with at least 2100 kilo caries per day. World Food Programme (WFP,1996), defined food security as a situation whereby all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life. Food security also looks at issues around micro-nutrient content of food so as to avoid hidden hunger. Food security is built on four broad pillars which are:

- **Food availability**: sufficient quantities of food available consistently
- **Food access**: having sufficient resources to obtain appropriate foods for a nutritious diet
- **Food utilization**: appropriate use of food based on knowledge of basic nutrition and care as well as adequate water and sanitation,(Broca:2002,6)
- **Stability**: Sustainable means of accessing food, (FAO 2011)

In Africa**,** food security remains one of the fundamental challenges for human welfare. According to Benson (2004), 200 million people in Africa out of the over 912 million people in the African continent are undernourished and their number has increased by 20% since 1990. Africa is the only continent in which per capita food production has been on the decline over the past 20 years (World Bank, 2008).The above view is shared by Deverex (2000), whose study established that Sub-Saharan Africa (SSA) is the only region in the world currently facing widespread chronic food insecurity and persistent famine threats. The issue under study, therefore, lies in the region. It is also imperative that a study be carried out to establish ways of dealing with the food insecurity in the region. Evidence of widespread food insecurity in SSA can be empirically linked to 2000 World Development report which states that, nearly half of the SSA population was living below the international poverty line of US$1.00 per day (Benson 2004; OECD, 2001; UN 2005). While income poverty ($1/day) may not be applicable to the situation, it still remains an important vulnerability indicator in general. This proportion is the highest world over and has failed to fall over time. For example, according to Deverex (2000) in East Africa, the proportion of living below US$1.00 per day fell from 27% to 15% from 1987 to 1998 and in South Asia, it fell from 45% to 40% within the same period. In SSA, the proportion remained unchanged at 46%, and because of population growth, the number of poor Africans rose from 217 million in 1987 to 291 million in 1998 (Deverex: 2000). In Africa,33% of small scale farmers are undernourished, largely due to poor farming practices (FAO/WFP, 2010). This entails that, generally, poverty levels in SSA remained high globally despite other positive changes in other regions.

Zimbabwe is one of the SSA countries that face food security challenges. In fact, the country has been experiencing successive food shortages for nearly a decade, from 2000 to 2010, although there were seasonal droughts since 1980 and beyond (CSO, 2011). Maize is the staple food for Zimbabweans, and the country's maize production from 1980 to 2011 where the aggregate maize production is below 1 000 000 metric tonnes (Mt) resembles high food insecurity. For example 1983, 1992, 1995, 2002, 2005, 2007 and 2008 were extreme drought years, with the total maize production of less than 1000 000 metric tonnes against a nation requirement of 1 800 000 Mt as illustrated by CSO statistics below:

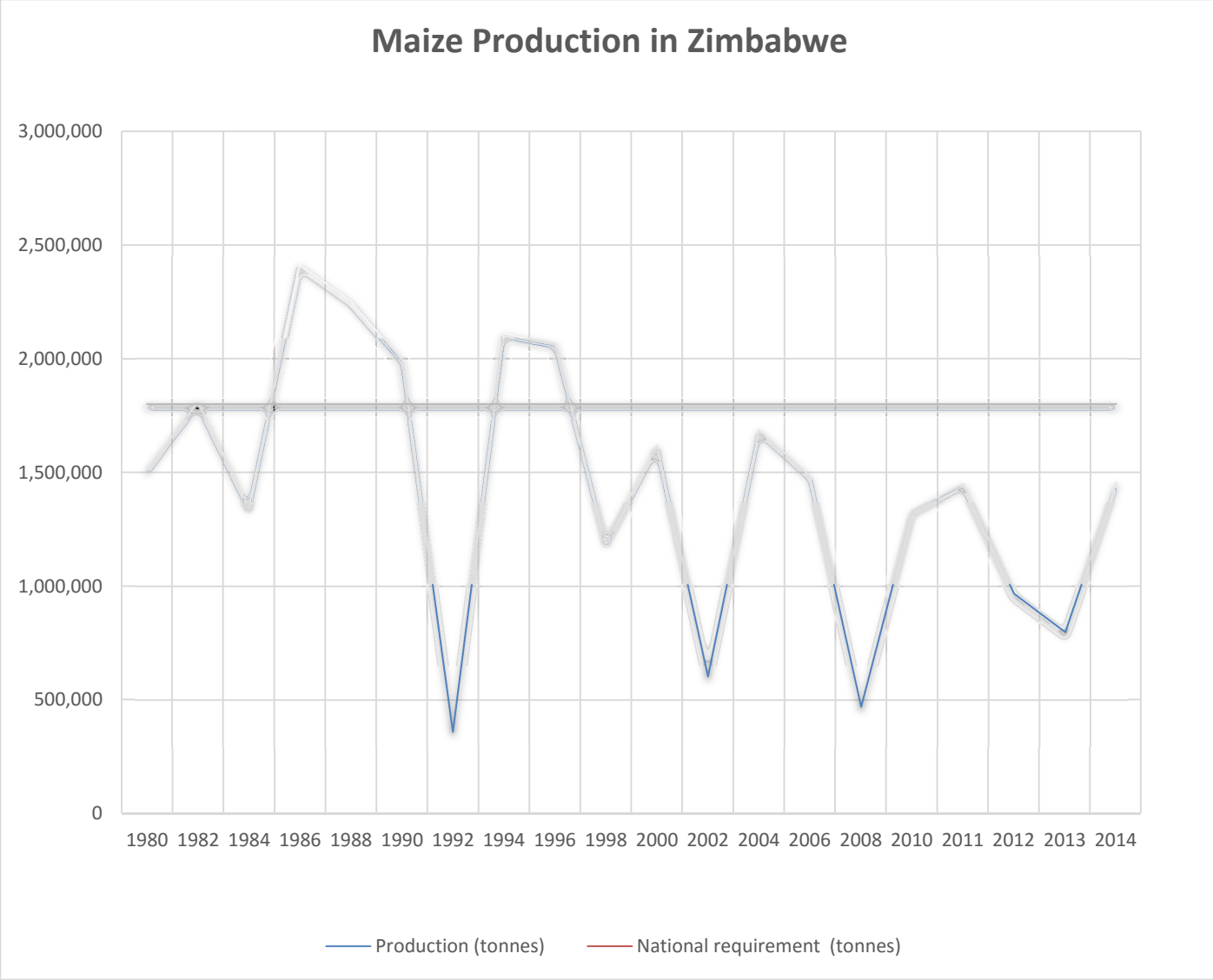

Figure 1: Analysis of food production levels since 1980 compared to national requirements

The trend graph shows that for the past 34 years, Zimbabwe managed to produce enough for the national consumption most of the years in 1980 - 1997. As from 1998 to 2014, Zimbabwe was producing far less than the national food requirement. The most severe years were 1992, 2002 and 2008 where production levels were less than 700 000 Mt. Low food production was mainly due to the adverse effects of droughts, prolonged dry spells and poor rainfall distribution.

If one is to consider all years with less than 1 800 000Mt annual maize production as food insecure years, we remain with only 29% (10/34 annual seasons) as food secure years from 1980 to 2014. This shows that food insecurity is a major problem in the country. Notwithstanding the effect of drought on food security, the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA, 2010) argues that agricultural inputs,

farming methods and resource management also influence food insecurity in Zimbabwe. The above view is allied to the notion that Zimbabwe is an agro-based economy. The onset of the economic recession in 2000 exacerbated the chronic shortages of key agricultural inputs. The 2008/09 agricultural season was characterized by the highest ever recorded shortage of agricultural inputs in Zimbabwe (UN-OCHA, 2010).

Statement of the problem

Environmental risk and limited farming equipment expose most farmers to the adverse effects of the global warming (Devereux et al, 2000). This entails consideration of technological advancement in the agricultural sector, for example, conservation agriculture. Investment in conservation agriculture is a critical component of food security. However, Gokwe South communities are characterised by narrow investment portfolio, primarily in cotton farming and animal husbandry to some extent, due to communities' lack of income, poor loan facilities and series of droughts that led to high consumption expenditures as opposed to investment and savings, (Christian Care Food Security 2009).

The major problem in Gokwe South District is that, not much has been done to establish the impact of CA on household food security in the district. There are reports that claim that CA has improved food security in the District and there are other reports that suggest that food shortages are on the increase in the district, (Oldreive 1993: Giller 2009). Food insecurity is severe in child-headed households which constitute 2% and the female headed households (13%), (SAFIRE 2004). It is these contradicting reports that have triggered a need for this investigation. The people of Gokwe South adopted CA in 2004 in some wards of the District and little has been done to establish the effect of CA on food security in the area under study.

Purpose of the study

The purpose of the study is to find out how new farming technologies or systems like conservation agriculture contribute towards food security in Gokwe South District, taking cognisance of the poor majority. The study analysed the causes of food insecurity, current farming methods and the attributes of CA to food security in Gokwe South.

Research Questions

1. How farmers perceive impact of conservation farming on food security in Gokwe South District?

2. What challenges do CA farmers face in Gokwe South District?

3. What CA opportunities can be exploited by the farmers in the District?

Objectives of the study

The study was centred on three fundamental objectives. The first one was to assess farmers perception of conservation agriculture in Gokwe South District. The second one was to document the opportunities and challenges of CA technology on food security in the district. The last objective was to assess CA contribution to food security in Gokwe South District.

Conceptual Framework

Conservation Agriculture (CA)

This is a concept for resource-saving agriculture crop production that strives to achieve acceptable profits together with high and sustained production level while concurrently conserving the environment (FAO, 2007). Dumanski, (2006) beheld conservation agriculture as a conservative farming technology based on principles of rebuilding the soil, optimizing crop production inputs, including labour and profits.

Many tend to use CA interchangeably with Conservation Farming (CF). They are similar terms with slight differences as can be noted in the following explanations:

CA is a farming system or practice which aims to conserve soil, labour and water by using blanket cover (mulch) to minimise runoff and improve the conditions for plant establishment and growth. This practice includes various mechanisms like use of hand hoes for basin formation, jab-planter, animal drawn direct seeder, animal drawn ripper and motorised equipment like tractor mounted direct seeder, tractor mounted sub-soiler and multi row tractor mounted direct seeder.

CF is solely use the of hand hoes for basin formation. The practice is referred to as Model 1 conservation agriculture because it is the first step towards mechanised CA. CF only refers to use of hand hoe in basin formation.CA is an approach of managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three major principles, which are: Continuous minimum mechanical soil disturbance, permanent organic

soil cover (mulch), and diversification of crop species grown in sequences and/ or associations (Crop rotation).

Food Security

According to World Food Programme (WFP), 1996 definition, food security is a situation when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life. The working definition of food security in the study is focused on food availability as defined by WFP but with much emphasis on balanced diet so as to cater for hidden hunger. Hidden hunger refers not to the overt and obvious hunger of poor people who are unable to afford enough to eat, but to a more insidious type caused by eating food that is cheap and filling but deficient in essential vitamins and micronutrients. This is common in Third World countries, where families may fill themselves with cheap rice or sadza (thick porridge) but are unable to afford the fruit, vegetables and meat needed to provide a balanced diet. This can also be traced from NGO food assistance to the poor which is normally characterized by cereals mainly, for instance, maize grain.

Livelihood

This term is sometimes referred to as means for survival. Scoones (1998) defined livelihood as capabilities, assets (including both material and social resources) and activities required for life. A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets while not undermining the natural resource base, (Scoones 1998). Under the study, Livelihood is understood as the main sources of income for food and other basic requirements for a living. Without livelihood, there will be no life.

2.0 Materials and methods

Both secondary and primary data were collected and analysed. The study was a mixed methods type of research where both qualitative and quantitative data were analysed in a single study. The main drive why the two were combined is that they provide a better understanding of the research problem. One type of research: qualitative or quantitative, was not enough to answer the research objectives. The research questions comprise of qualitative information, for instance, farmer's perceptions, experiences, challenges and prospective views towards attributes of conservation agriculture to food security. Within the research framework, it was noted that to fully answer the research goal, qualitative information was to

be augmented by quantitative information like yields, metric tonnes per CA farmer per hectare. Quantitative data were crucial in triangulating qualitative information. Combining both qualitative and quantitative research methods comprehensively addressesresearch thrust.

The data collection methods used includes household (H/H) in-depth interviews, Key Informant Interviews (KII), Focused Group Discussions (FGD) and Most Significant Change (MSC). These tools were complemented by observation technique (On site visual inspection) mainly through farmer-field visits. The data collection tools were designed to answer the research questions in line with the Sustainable Livelihoods Framework (SLA).

The study used Sustainable Livelihoods Framework (SFA) to analyse food situation in the study area. SFA is one of the key approaches employed by most humanitarian and development practitioners in analysing food security at community level. SFA states that food security activities are centred on five pillars which are referred to as the 5 main capital assets;

- **Human**– Knowledge & Skills, Capacities – Labour, Education, Health,
- **Natural**– environment, water, trees, pastures, aquatic resources, Bio diversity,
- **Social**- Networks & connections, Membership in institutions, formal & informal groups, Participation in community, meetings, social and religious occasions
- **Economical/Financial**- savings, credit, remittances, pensions, wages,
- **Physical**-House, Livestock, Tools, Water supply, Land, Ponds, transports

The five pillars of the SLA are based on human and natural capital assets which constitute cornerstone of livelihoods activities, especially to agro-based economies like Zimbabwe. Gokwe South District's economy is based on natural capital like land, i.e. soil fertility and rain fed ecology. Livelihoods source for Gokwe South communities are based on a combination of subsistence cash crops farming and food crop farming that makes it a typical example to represent agro-based communities. The main crops are cotton and maize.

In examining food security in line with conservation agriculture, the researcher carried out an in-depth analysis of kilocalories consumed per household and individualcompared to yields harvest using modified Household Economic Approaches (HEA). HEA was developed by Save the Children-UK and the Global Information and Early Warning System of the Food & Agriculture Organization (FAO) of the United Nations in the early 1990s mainly to strengthen food security analysis in planning and implementation of humanitarian food aid

programmes. This was invented after the realization that poor rural people in poor nations do not solely depend on own production for survival, for instance household crop production. It was discovered by Tanya Boudreau (2000) that vulnerable households, in responding to a shock like drought, would employ a range of strategies to get food and money to access food. With HEA framework, food security goes beyond the ability to own production as it also enables effective analysis of crop production, including contribution of specific crop type or farming technique like CA to household food security (see details in attached HEA Appendix 01).

HEA is an analytical framework used to assess household accessessential food and non-food needs. The analytical process involves three steps, beginning with a baseline picture of all food and income sources, as well as expenditure patterns. Typical HEA assessments triangulate sources of food (to factor in CA food contribution) with income and expenditure, allowing for 'in-field' analysis. Food access is expressed as a percentage of minimum energy requirements, taken as an average food energy intake of 2100 kcals per person per day. Annual income earned by the household is balanced with expenditure allowing the interview to capture a reliable account of the different income activities each household is engaged in.

3.0 Results

A total of 403 farmers were interviewed during the survey from four purposively sampled wards of Gokwe South District namely Nemangwe 2, Njelele 2, Njelele 3 and Chisina 3. The table below shows the number of farmers interviewed from each of the wards.

Table 1:Households interviewed .

Ward Name	Ward #	Interviewed farmers
Nemangwe 2	12	73
Njelele 3	14	120
Njelele 2	15	70
Chisina 3	25	140
Total		403

Source: Survey data

The households were characterised under the following subtopics:- farmer status, sex, marital status, educational level and occupation. Seventy five percent of the interviewed farmers

were practicing CA in their fields and nearly 5% once practiced CA but stopped doing so over some years (dis-adopters) while 20% have never practiced CA in their fields.

The survey results show that 59.1% of the farmers are female while 40.9% are male and 74% of the farmers are married whilst 3.7% are divorced and 20.6% are widowed and single. Farmer marriage status was captured as one of key parameters in analysing attributes of CA and food security as well as comparing farmer status.

A total of 10% of the farmers did not receive formal education while 90% has undergone some form of formal education training ranging from primary to tertiary education.

The household heads in Gokwe are aged 46.78 (SD 13) years and the average household size is six with four of those contributing to labour for agriculture.

Table 2: Characteristics of Household head and the Household

	N	Minimum	Maximum	Mean	Std. Deviation
Age HH head	397	15	93	46.78	13.007
Household size	403	1	19	6.00	2.100
Orphans	403	0	8	1.04	1.404
Labour	403	1	10	4.03	1.567

Analysis was further disaggregated by whether or not farmer is practicing CA and to check if these differences are significant using chi-square test. Table 6 shows the results.

Sources of Household Food

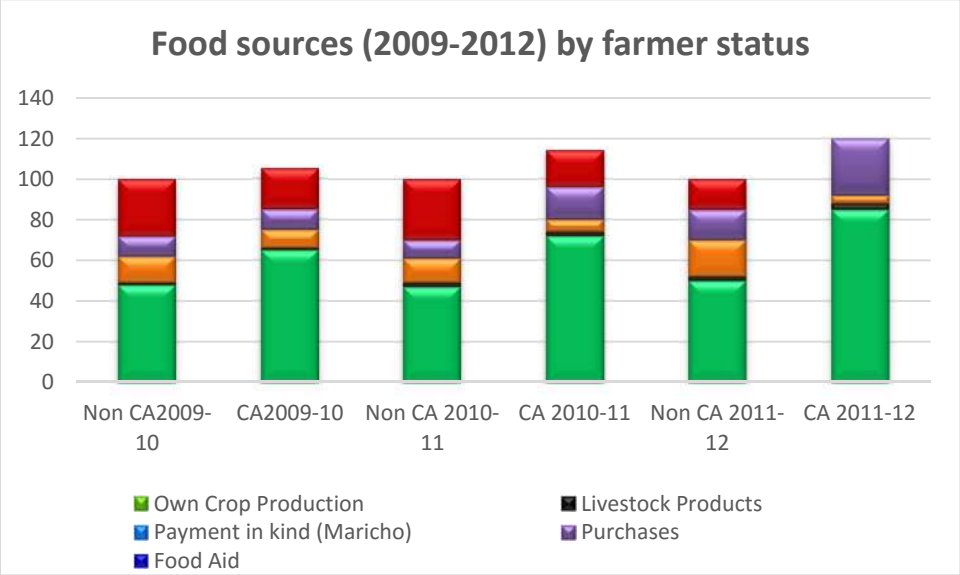

Figure 2: Household food sources

As presented in figure 2, the primary source of food consumed in the households is from their own production. More than 50% of the Gokwe population depends on crop production and animal rearing for their livelihood. Domestic food production plays an important role in Gokwe food security. Food Aid is the second source of household food security. The market is the third source of households' food supply. Though the majority of households are engaged in farming, almost all households are net purchasers of food.Over 70% of the households do not produce sufficient quantities to cover the consumption needs over the season. Some of them sell part of their production to cover the production expenses and other household needs, such as children school fees, clothing and household groceries.

Fundamental Causes and Attributes of food insecurity in Gokwe South District-Zimbabwe

The survey results showed thatGokwe South District is characterised by high levels of food insecurity (74%). The prevalence of food insecurity is reported by the farmers who indicated that the food they harvest do not last a year.

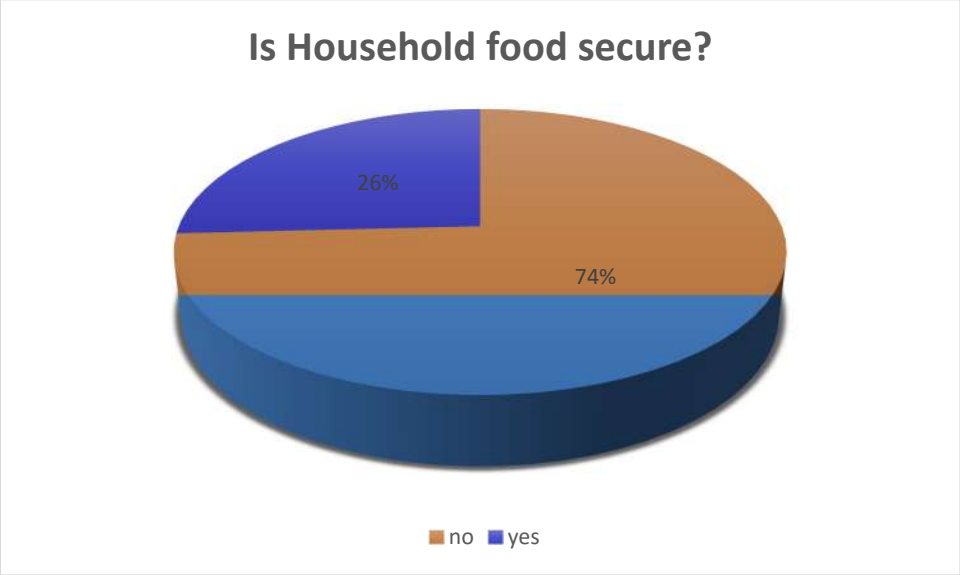

Figure 3: Food security Status in Gokwe

Causes of Food Insecurity in Gokwe

Frimpong (2013) generalize the main causes of food insecurity as poverty and food shortage. However, in this study the focus was on specific details pertaining root causes of food insecurity in Gokwe South District. Factors behind food insecurity were found to be immense, diverse and interlinked. The survey revealed that drought, unavailability and unaffordability of inputs;lack of productive assets, poor infrastructure, pest and diseases and poor markets are root causes of food insecurity.Severity of these factors to food security was rated differently by farmers with different characteristics as shown in figure 8.Similar observations were made byRosegrant et al., 2001 who concluded that food shortages in southern Africa are an on-going problem, and long-term projections suggest that regional food production per capita is likely to diminish in future.

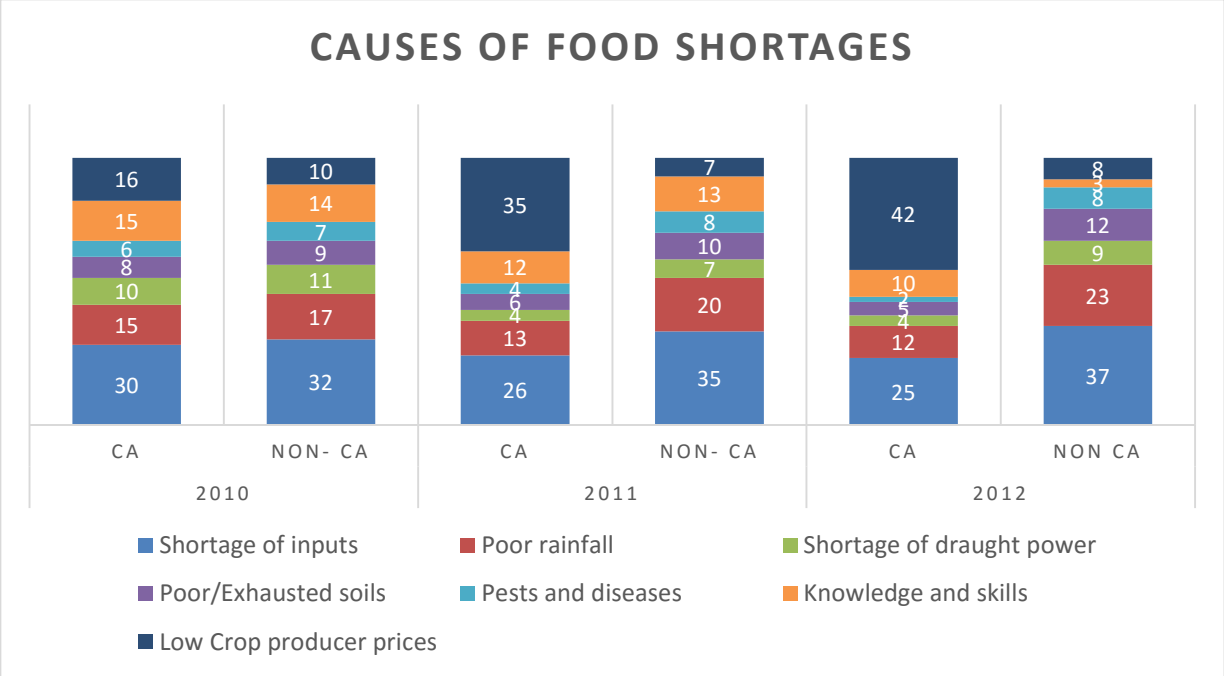

Figure 42: Causes of Food shortages over 3 years in Gokwe

Main causes of food insecurity raised by farmers categorized into two, CA and non-CA farmers in Gokwe South District during survey data collection. Main contributors of food insecurity raised by farmers were drought, poor markets, shortage of drought power, inputs and poor rainfall

Crop Productivity in Gokwe

An increase in yield under CA farming system as compared to conventional practices was noted in all the four wards where data was collected. Increase in yield production is a positive proxy indicator towards food security. This might be controversial among scholars since there are various factors which affects or contribute towards food security, thus why in this research there was an element of analysing sources of income and expenditure pattern of households under modified HEA. Increase in yields was not homogeneous across research sites they varied from one area to the other. In general CA yield was higher than the conventional farming system as detailed below:

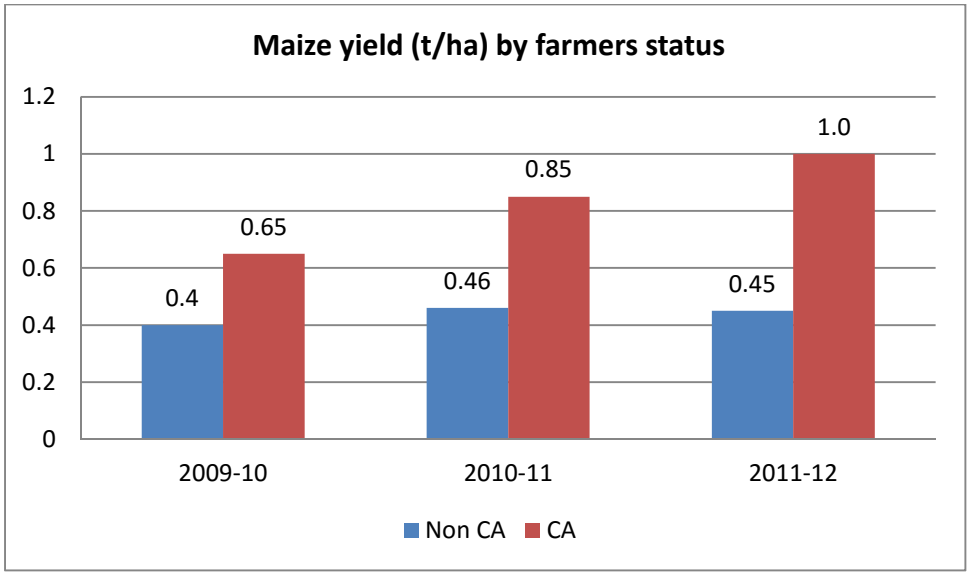

Figure 5:Results of maize yields from 2009/10 farming season to 2011/12 under two different farming systems, conservation agriculture and convectional farming system in Gokwe South District.

The yields results show that during 2009/10 farming season on average non-CA harvested 0.4 tons/ha as compared to 0.65 tons/ha by CA farmers. In 2010/11 farming season non-CA farmers harvested about 0.46 tons/ha while CA farmers harvested 0.85 tons/ha of maize during the same period. CA farmers got yields of up to 1 ton/ha during 2011/12 farming season as compared to 0.45 tons per hectare of maize obtained by non-CA farmers during the same period.

Labour Input under Conservation Agriculture

Results shows a positive yield benefit from most research scientists which is in line with Gokwe results. However there is a huge mismatch on the fact that most CA researchers are of the idea that CA is labour saving (FAO, 2009; IIRR and ACT2005). According to FAO, 2009, "CA eliminates power-intensive soil tillage, thus reducing drudgery and labour required for crop production by more than 50% for small-scale farmers." In support of this view, Friedrich and Keinzle (2007) discovered reduction labour requirements for tillage, land preparation and weeding in CA plots in South America. CA's high demand for labour is attributed mainly to land preparation as farmers in Gokwe indicated that basin formation, precision planting and weeding was more difficult in mulched fields as compared to bare fields. Similar sentiments were echoed by Baudron et al (2011) who noted that the primacy of the labour peak at first weeding which explains farmers' preference of technologies that save

labour such as ploughing and residue burning. Ploughing reduces weed infestation and is more effective in controlling perennial weeds than minimum-tillage (Vogel, 1994).

CA Challenges: Core Principles not Universal applicable

CA farmers in Gokwe South District were tasked to rank based on the most commonly practised and importance of CA principles using piling method. In general it come out clearly that CA farming system is not 100% practiced as a package by most of them, but farmers are adopting components they feel are critical to them. However, 40% of the visited farmers are practising CA holistically implementing all three key principles of the farming system. Most of those farmers who adopted all principles are concentrating CA activities on a small piece of land on average about 0.5 of a hectare. Under normal circumstances it was discovered that they are practising CA at home stead.

Survey results indicated that mulch proved to be one of the most difficult CA principals. Majority of the CA farmers collect crop residue and keep them at a protected area soon after harvest then retain residue to the field during farming season. This is done as way of addressing free grazing challenges since livestock consume residue in the field. The idea is good but the soil will be exposed to heat wind and water during off farming season. This also affects the soil organic ecosystem which is fundamental in enhancing soil fertility. Therefore, there is need of coming up with a strategy to protect residue specifically in free grazing communities**.**

Mulching

The farmers were asked on the type of mulch they use in the CA fields. A total of 3% of the farmers indicated that they used maize stover while 28% used a mix of grass and stover. Only 2% of the farmers indicated using no mulch in their fields. Through FGDs and key informant interviews, it emerged that the mulch types used had multiple uses and thus a household was faced with a task on how to secure mulch for the CA fields.

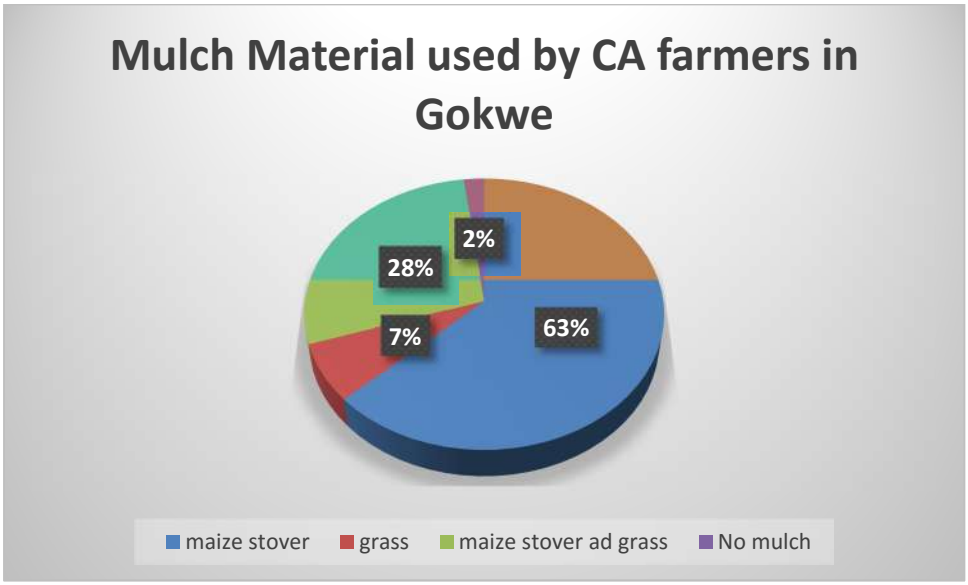

Figure6: Mulching materials in Gokwe

4.0 DISCUSSIONS AND CONCLUSIONS

Analyses of drought and food security were categorized into two, CA and non-CA farmers (Dis-adopters and those who have never practiced CA). It was noted 17% of the interviewed non-CA farmers listed drought as the main root cause of food insecurity in 2010. Further analysis for 2011 and 2012 showed 20% and 23% respectively of the interviewed non-CA farmer's purported drought as the main cause of food insecurity in the area. On average 20% of non-CA interviewed farmers for a period of 3 years rated drought as one of the main root cause of food shortages in Gokwe South District characterized by prolonged dry spells which negatively affected crop growth. According to Heisey and Edmeades (1999) drought is one of the major contributor to food insecurity, contributing to 25% loss in maize production globally Drought is also exacerbated by high temperatures hence a combination of drought and heat stress is disastrous to agricultural productivity (Cairns et al., 2013). Lobell and Burke (2010) disclosed that an increase in temperature of 2°C would result in a greater reduction in maize yields than a decrease in precipitation of 20%. Similarly, a recent study in Tanzania also indicated that increasing temperatures would result in a greater reduction in maize yields than increased intrapersonal variability in precipitation (Rowhani et al., 2011).

Frimpong (2013) discovered that for the past three decades, Africa has become subject to erratic weather patterns and is often plagued by prolonged droughts followed by floods. These natural shocks trigger adverse consequences, with food insecurity being the major challenge (Cairns et al., 2013). Sub-Saharan Africa is the second-most severely affected

region for climatological disasters among the developing regions of the world Frimpong (2013).

According to Twomlow et al., 2005 drier areas of southern Africa, farmers experience a drought once every two to three years. In Zimbabwe vulnerable farmers were supported by NGOs and government with seed and fertilizers. However, because of lack of appropriate land and crop management interventions, vulnerable farmers were not able to translate relief investments into sustained gains in productivity and incomes (Rohrbachet al.2004: 2005). Therefore, CA might be of paramount importance to rural farmers since basins help to collect rainwater and promote infiltration of the water into the soil which potentially makes it available to crops. Basins enhance plant available water capacity. Mulching enhances water infiltration into the soil and reduce amount of water lost through evapo-transpiration. Conservation agriculture also improves soil health (texture, structure, fertility) through minimum tillage and mulching which adds organic matter to the soil. This makes the practise much more sustainable for the future. To improve crop production in the marginal rainfall regions of Southern Africa, farmers have to adopt cultural practices that conserve fragile soils and extend the period of water availability to the crop (Twomlow and Hagmann 1998).

Drought ranks as the single most common cause of severe food shortages, particularly in developing countries, and represents one of the most important natural triggers of malnutrition and famine (FAO 2011). Drought has direct negative impact on food security since it affects four main pillars of food security – availability, stability, access and utilization. In general drought negatively affects agricultural crops, lower yields in both crop and livestock production, increased livestock deaths, increases insect infestation, plant and animal diseases, damage to fish habitat, forest and range fires, land degradation and soil erosion (FAO 2011). Its impacts on human health include increased risk of food and water shortages, increased risk of malnutrition and higher risk of water and food-borne diseases.

Exhausted soils were one of the factors mentioned by farmers behind food insecurity in the District by both CA and non–CA farmers. A total of 18 farmers out of 303 CA farmers indicated exhausted soils as one of the contributory factor to hunger in their area. The severity of poor soils varies from one year to the other in 2010, 8% of CA farmers interviewed mentioned poor soils as one of the factors. This was exacerbated shortage of inputswhich mentioned by 6% of the interviewed farmers in 2011. On the other hand 10% on

average of non-CA farmers interviewed for a period of three years, (2010-2013) indicated poor soils as one of the contributory factors to food insecurity.

The importance of having good soil is a prerequisite condition for successfully growing of any crop. However, it was discovered that many African soils are of low quality (Seiler 2013**).** A study by the US Department of Agriculture points out: "Fifty five percent of the land in Africa is unsuitable for any kind of agriculture except nomadic grazing." (Eswaran, et al., 1997). This indicates that many soils provide poor amounts of organic matter and have a low soil quality and fertility. According to Andre (2009) African soils have an inherently poor fertility because of lack volcanic rejuvenation which has been exacerbated by inappropriate land use, poor management and lack of inputs.

Soil fertility decline is a major constraint to crop productivity on smallholder farms in Africa (Rusinamhodzi et al. 2013). In view of this, Ye and Ranst, (2009) predicted a 9% loose in crop productivity by 2013 if the soils are to be degraded at the current rate. However, Productivity losses will increase to the higher levels of 30% by 2050 should the soil be degraded at twice the present rate (Ye and Ranst, 2009).

In line with this, some researchers are of the view that barriers to improved crop productivity and food security in Zimbabwe are directly linked to poor soil fertility status and climatic volatility (e.g. Rurinda et al., 2013; Rusinamhodzi et al., 2013). These conditions are also similar to other countries in Southern Africa (Challinor et al., 2007). The situation is further worsened by limited resources (land and capital) that smallholder farmers possess (Giller et al., 2006, 2011b). Land and capital are part of the key components of SLA frame work hence they are of paramount importance in sustaining food security. In some parts of Southern Africa soils are severely degraded and have low organic matter as a result of continuous mono-cropping (Sanchez, 2002; Oswald, 2005; Rodenburg et al., 2005). Recent studies in Kenya suggest that minimum tillage and crop residue retention may be not be lucrative on poor soils or sites hence under that situation emphasis should be on soil rehabilitation first (Njoloma et al., 2014).

Southern Africa is one of the most affected regions by land degradation, a long term decline in ecosystem function measured in terms of net primary productivity (Bai et al. 2008). Malley (2006) is of the view that household food insecurity and poverty in Southern Africa are closely linked to soil and land degradation (Malley et al. 2006). High rates of erosion and

land degradation are a result of inappropriate tillage and cropping system (Elwell 1989).This view fully supports CA farming system since it reduces sheet erosion and protects soils from splash effects of rain and windy erosion. Therefore, a farming system which maintains and protects natural resources for future consumption is ideal. The Global Assessment of Land Degradation and Improvement identified 24% of the global land area that was degrading over the previous 25 years and the worst affected is Southern Africa (Bai et al. 2008). However, CA has been promoted in southern Africa since late 1990s with the aim of reversing the effects of declining soil fertility and productivity on current farming systems as well as adapting to projected increase in climate variability and change (Thierfelder et al., 2014).

Poor inputs markets especially accessibility and affordability of certified seeds and fertilizers were mentioned as one of the main contributory factors to food shortage in the study area.Research figures revealed that there were few non-CA farmers who mentioned seed and fertilizers as one of contributing factors to food insecurity compared to CA farmers. CA farmers understand the importance of improved seed in agriculture. May be that is why majority of CA farmers raised shortage and unaffordability of inputs as one of the causes of low productivity in the district. CA farmers were trained on proper farming practices including use of improved seed varieties and fertilizers.

Marketing problems prevailing in the District are in two forms, input and output markets. Under input markets it was noted that in the some rural parts of the District there are no readily available agricultural inputs. Farmers in these areas cannot access fertilizer and certified seeds mainly due to unavailability and unaffordability. Poor access to inputs results in low agricultural productivity. Output markets are very crucial in agricultural sector. GokweDistrict is characterised by poor output markets dominated by Grain Market Board (GMB) and cotton companies. Moreover, farmers will only increase production if they have access to viable markets for their agricultural outputs (Elliott 2010). With this importance of the role of markets in agricultural sector, one might be justified in concluding that farming systems or innovative technologies are a component of the broader value chain. Hence, in attaining food security the whole value chain should be considered. This is in line with the U-impact pathways that include not only tailoring technology to farmer circumstances but also includes the input and output value chains (Dixon et al., 2007).Low crop producer price at the market was one of the factors mentioned as causes of food insecurity in Gokwe South

District. However, the severity of producer price on food security varied from each year to the other as mentioned by different farmers.

Lack of draught power was one of the factors raised by farmers as contributing factor to food security. On average from 2010 to 2012, 6% of CA farmers mentioned lack of draught power as one of the factors causing food insecurity in the District. On the other side of non-CA farmers, 9% of farmers believed that shortage of draught power is the main cause of food insufficient in GokweSouth District.

During 2012/2013 farming season 4% of CA farmers as compared to 9% non-CA mentioned draught power as one of the main problems. This might be attributed to the fact that most of the CA farmers are forming planting basins using hoes-conservation farming hence they are no longer losing on time whilst waiting for drought power from few community households who own cattle. Reduction in machinery and fuel costs has been one of the major incentives for the large-scale adoption of CA in North America, South America and Australia (Kassam et al., 2009). In the less mechanized systems in developing countries, CA may enable early planting, as the number of operations required to prepare the land are reduced (Haggblade and Tembo, 2003).

The scarcest input to smallholder farming is often energy, particularly the human energy or farm power that is required for land preparation, crop establishment, weeding, harvesting and transport (Kienzle 2014). Many smallholder farmers are women and youth who carry the major burden of arduous hand labour and is a main reason why rural youth in developing regions migrate to urban areas in search of an alternative to rural smallholder agriculture (Kienzle 2014). According Kienzle (2014) Conservation Agriculture (CA) presents an opportunity for smallholders to reduce or even eliminate the need for land preparation and heavy digging.

Gokwe South District results shows that CA yields increased progressively by 0.35 tons per hectare from 2009 to 2012. In 2009 maize yield under CA was 0.65 ton/ha, in 2011/12 farming season the yield was about 1 ton per hectare. This is in line with a meta-analysis of the long-term effects of conservation agriculture on maize yield found increases in yield over time with practices that included crop rotations and high input use in low rainfall areas (Rusinamhodziet al., 2011), but most yield increases are not observed in the early years of adoption. However, in this study CA farmers who adopted the technology at least three years

were interview separately but a progression trend on yield was noted. In comparing aggregate yield difference between CA and non-CA during the same period the difference is more than half a ton per hectare. This differential results are similar to what has been discovered by other researchers in other areas although difference in yields were not the same but CA yields tend to be above non-CA yields (Tshuma et, al 2012; Mazvimavi 2011; Marongweet,al 2011; Mazvimavi and Twomlow, 2009 and Ngwira et al.,2013). Most significant stories from some farmers in the district were a clear testimony of improved productivity:

<u>Most Significant Change Story:</u> Transforming agriculture through CA for resource-poor small scale farmers in Gokwe South District

Enos Tekede lives in Chisina 3 Village in Ward 25 of Gokwe South District in the Midlands Province. Enos had been growing maize since 2001, but without water for irrigation and using poor, traditional farming practices, his yields were very low. With erratic rainfall, he would harvest less than one tonne from his plot, forcing him to register for food relief services from the government, and other humanitarian agencies.

With training and technical assistance in conservation agriculture techniques from Concern Worldwide and Agritex in 2005, Enos used the good agricultural practices as a winning strategy for his once impoverished household. Enos and other farmers in the district have also recorded multi benefits as a result of using conservation agriculture techniques – productivity, less labour, improvement water and fertility management, among others.

Project agronomists provided trainings on choice of planting material, integrated pest and disease management, correct application of fertilisers and timeliness of operations.

Figure 1: **Left:** ***Chisina 3, 2012/13 Field-day hosting farmer Tekede with wife and granddaughter (back row) happily joined by a Seedco official, Mr Chigombe (kneeling and also observing well-formed cobs on the right photo).***

Learning from farmer managed demonstration plots and transferring the knowledge and practices to his own plot, Enos said:

" Prior to introduction of CA in my village I used to produce less than three bags of maize…..used to supplement by household food requirements through 'maricho' casual labour. With holistic adoption of CA, I am now producing more than four tonnes of maize". Before, he did not get any income from his farming operations. During the last cropping season Enos generated $1,000 from the sale of four tonnes of maize, after incurring production costs of $200.

He also said: "I did not know that changing my farming practices would make a huge difference to my yield and income. I will use my income to pay for my children's school fees." The farmer noted than being a poor farmer without draught power he used to plant late after working in other fields with cattle, where he would be paid in kind-draught power usually after the first effective rains. "With CA I am now planting well on time using the first effective rains coupled with precision application of inputs. Being a poor farmer, I benefited a lot in making use planting basins which fully utilise inputs, for example, fertiliser, water and seed. As you can see my life drastically changed from subsistence to commercial farming. I used to be a laughing stock in the community. Now, I have been the best farmer of the year for the past three years in Ward 25 of Gokwe South District" said Enos.

Thierfelder and Wall (2012) concluded that in low-yielding environments CA has potential to double the maize yields obtained under conventional tillage, which was previously shown by in a study carried out at Zimuto Communal Area, Zimbabwe. Under semi-arid conditions of southern Zimbabwe, CA (planting basin and rip-line seeding systems) produced 102–142% more cowpea grain compared to conventional practice in a drought year (Mupangwa,et al 2012). Similar results were also noticed in regional study on long-term in Southern Africa where Maize yields under no-till with mulch retention were marginally better than under conventional tillage (Thierfelder, 2012).

In line with this, Rusinamhodziet, al., 2011 echoed similar findings when reported an increase in yield in no-tillage with rotation over no-tillage without rotation in long term experimental trials. Most of the studies reporting crop yields with rotation showed positive effects in no-tillage systems agreeing with the results of Karlen et al. (1991, 1994a, b), who reported that rotations are likely to produce greater yields across soil fertility regimes. Higher yield for no-tillage in rotation than in mono cropping is attributed to a combined effect of multiple factors that include reduced pest infestations, improved water use efficiency, good soil quality as shown by increased organic carbon, greater soil aggregation, increased nutrient availability and greater soil biological activity (Van Doren et al. 1976; Griffith et al. 1988; Hernanz et al. 2002; Wilhelm and Wortmann 2004; Agyare et al. 2006; Kureh et al. 2006).

As observed in Gokwe South District higher yield of CA farmers compared to non-CA is not statistical equal to the difference from other research sites. Impact of CA on yields is site specific. Other authors report that there is often a larger increase in yield in low-yielding environments than in high-yielding environments (Lauer and Oplinger 1996; Porter et al. 1997). The larger yield increase of rotated crops in low-yielding environments means that this production strategy contains hope for most farmers Southern Africa. This point is important in that most of farming land in Africa is characterised by low rainfall and sandy soils (low yielding environment). The results of the meta-analysis suggest that rotation should be an integral component of tillage practices for supplying nutrients to maize (Francis and King 1988; Chikowo et al. 2004) and also for breaking pests and disease life cycles as found in other studies (Jordan and Hutcheon 2003; Sandretto and Payne 2007).

Gokwe yield results compared with other contemporary studies from other sites both in Zimbabwe and abroad, one might be justified in concluding that attribution of CA on food

security is site specific. This contradicts other CA loosely conclusions like suitability of CA to all farmers and on all soils (IRR and ACT 2005). In support of this scenario, during the studies field visits it was discovered that majority of the newly married and youths own small pieces of land. Newly married couples in Gokwe traditional they are given a small piece of land by the parents as part of culture for them to feed themselves. On the other side capital assets of these new families in general is low hence they cannot afford to own large piece of land. With a small piece of land of less than 0.5 hectares one cannot practice CA since crop rotation will not be feasible yet is one of the main three principles of CA. Moser and Barrett (2003a,c), concluded that poorer farmers with little land are much less able and less likely to adopt crop rotation than richer farmers with more land.

Knowler and Bradshaw (2007) argue that for CA strategies to be successful they should be tailored to fit local conditions and this observation is echoed by Erenstein (2002) who says that the success of CA and soil conservation technologies depends on the local bio-physical and socio-economic environments. Therefore, rigidity and universal prescription of three principles of CA should be relaxed for instance with limited arable land one may opt for intercropping of cereal and legume within a small piece of land. This still remains CA without crop rotation but with intercropping. On the same point one may opt to replace crop residue (mulch) with intercropping as long as there is minimum disturbance of soil CA concepts will be in play.

MSC: Farmers realising huge benefits of crop rotation in CA farming system

In Gokwe South District most of the best farmers since 2010 are coming from CA farmers. This current season 2014/2015, Mr Rudorwashe Maedza of Jiri 1 (ward 21) was one of the best farmers in the entire district. Despite survey scope and research wards it was interesting that best farmers from the rest of district wards are emanating from CA practising households.

Mr and Mrs Rudorwashe Maedza accompanied by Graham Bowker of Agricultural Partnership Trust during 2014/15 field day

Rudorwashe Maedza has been practising CA for almost decade. In the first two to three years he confirmed that labour requirement was high since he was not using herbicides. "I used to weed maize field three to four times in his first and second year of practising CA but since I managed to maintain weed free plot current I only weed once.'' Says Maedza. The secret for him for being the best farmer is centred on improved farming methods which compounded by uses of improved certified seed. "Magic of CA is in consistently rotating crops…I normally get amazing maize yield if I rotate the field with beans or groundnuts each year as evidenced existing crops in this field" says Maedza showing part of his field shown in the picture below.

Part of Mr and Mrs Rudorwashe Maedza's field the winner of 2014/2015 district field day

Maredza rotate his plot annually, he had a fixed kind of sequence he follows for instance groundnuts is usually followed by maize then cotton. These three different crops has unique characteristics in that cotton is a deep rooting cash crop, maize generate residue and groundnuts being a legume crops it critical in nitrogen fixation. Currently Maredza is harvesting two and half tonnes of maize from a hectare as compared to less than half a tonne prior to advent and adoption of CA.

In line with yield benefits of CA, ICRISAT (2009) observed yield advantages in CA systems compared to conventional farming across several agro-ecological regions of the country. However, the yield increases observed were higher in natural ecological region 3, which is a lower-rainfall area compared to region 2 in Zimbabwe. This may be attributed to the waterlogging effects that may be experienced in CA basins when they are used in high-rainfall areas (ICRISAT, 2009). In regards to this, Kassa (2008) revealed that CA is not equally suitable for all the European agro-ecosystems, (Hakansson, 1994). New technologies aimed at improving crop productivity often performs differently in different field types thus field type should be an integral component of the experimental design aimed at assessing such technological performance on smallholder farms (Zingore et al., 2007a, b). These disparities in terms of productivity show that there are many variable besides the farming system which contribute towards the ultimate yields levels.

Previous similar observations were found by Nzabi, 2002 which concluded that conservation tillage together with Lablab purpureus in Rachuonyo, Kenya, gave a higher maize grain yields of 2.6 t/ha compared to conventional tillage without cover crop that gave 1.8 t/ha (Nzabi, 2002). In Arusha and Arumeru, Tanzania, conservation tillage using a ripper gave overall maize yields of 2.8 t/ha, while conventional tillage gave 2.7 t/ha respectively (Mwalley and Mawenya, 2002). In Tanzania the difference yield between CA and conventional was not significant, this might be attributed to numerous factors like performance of ripper, rainfall, soil fertility.

Thierfelder and Wall, 2012 shared similar findings where they presented higher yields on CA plots on the sandy soils in dry seasons, but lower in very wet seasons because of waterlogging. They discovered that yields on clay soils were less affected by the rainfall season. However, crop productivity from CA systems increased at all sites over time owing to better management although significant differences between CA and conventional treatments were apparent only after several cropping seasons (Thierfelder and Wall, 2012). The disadvantages of long term benefits of CA on yield may not attract many farmers at a goal since farmers are food insecure they are much more interested in short term benefits. This is one of the reasons why they are not keen to conserve environment for future use.

Marongwe et al 2011 although he acknowledges the positive attribution of CA on yield improvement is sceptical of other factors like contribution of fertilizer and certified seed.

ICRISAT trials were comparing CA plot provided with inputs (seed and fertilizer) with plots without seed and fertilizer provision (Marongwe et al 2011). This tends to dilute the ultimate results in the sense that it will be difficult to distinguish attribution of the farming system from other factors like seed and fertilizer contribution. In Gokwe study farmers who were no longer getting external assistance were assessed differently comparing with non-CA farmer who did not get input support as well.

In an attempt to boost productivity in Africa, some researchers are advocating for sustainable agriculture intensification where by farmers should be producing more output from the same area of land while reducing the negative environmental impacts (Royal Society, 2009; Conway and Waage, 2010; Godfray et al., 2010). Sustainable agriculture in this context is directly linked to holistic approach characterised by multi-functionality of agriculture, value chain approaches, improving market access and development of rural non-farm activities. It also include integration of resource-conserving technologies and practices – integrated pest management, integrated nutrient management, conservation tillage, agro-forestry, aquaculture, water harvesting and livestock integration (Pretty et al., 2006).

Further analysis on intensity of labour requirements revealed that in Gokwe over 90% of the farmers are making plant basins using hoes and they are not using herbicides. On the same vain it is critical to note that herbicides are not part of the three principles of CA. Therefore if CA concepts are applied different worldwide it is not correct to generalize findings. The Gokwe survey showed that CA is labour intensive during land preparation and the weeding stage as farmers use hand hoe based system commonly referred to as conservation farming (CF). The demand for labour is also high in the first two years of CA adoption and this negatively affects the uptake of the technology as most farmers lack resources to buy herbicides. Herbicides when correctly applied help to reduce the intensity of labour requirements. Andersson and Giller (2012) concur with the above observation and say that herbicides are one of the most effective labour saving technologies available to farmers. The question which is open for further exploration is to what extend can farmers depends on herbicides when the majority of African smallholders are resource-constrained?

Theoretically, planting basins has potential to increase crop productivity due to water conservation and effective utilization inputs for example nutrient application (Van Niekerk,

1974). In support of labour intensity of CA, the transformation from mouldboard plough which was heavily promoted during the green revolution era to planting basins may entail substantial initial labour inputs for resource constrained farmers (Giller et al.,2006). Under low-input systems, labour is often the major input and is critical for timing operations; insufficient labour often leads to reduced land utilisation and late planting, leading to small yields (Giller et al.,2006; Muoni et al., 2013). For example, Nyamangara et al.(2013) reported that weeding in planting basins required double the labour in conventional tillage, and that weed growth and labour demand remained higher under planting basins tillage even after several years. Therefore, labour intensity problems associated with CA to be addressed in order for the system to be adoptable to African communities.

Commenting on the issue of CA labour requirements, Gowing& Palmer 2008; Giller et al., 2009) said that the evidence on CA in Africa may not be adequate or that under present circumstances CA may be inappropriate for the majority of resource-constrained smallholder farmers and farming systems. The above authors are a clear opposite of global evidence on CA adoption which suggest that CA practices work for small farmers (Fowler &Rockstrom, 2001; Haggblade&Tembo, 2003; FAO, 2008).

Cross tabulation of labour status and yield output during the survey revealed that farmers with average labour force and large labour force have comparative advantage in terms of getting higher yields as compared to farmers with small labour force. The table below shows cereal sufficiency of farmers in relation to the sizes of the labour force.

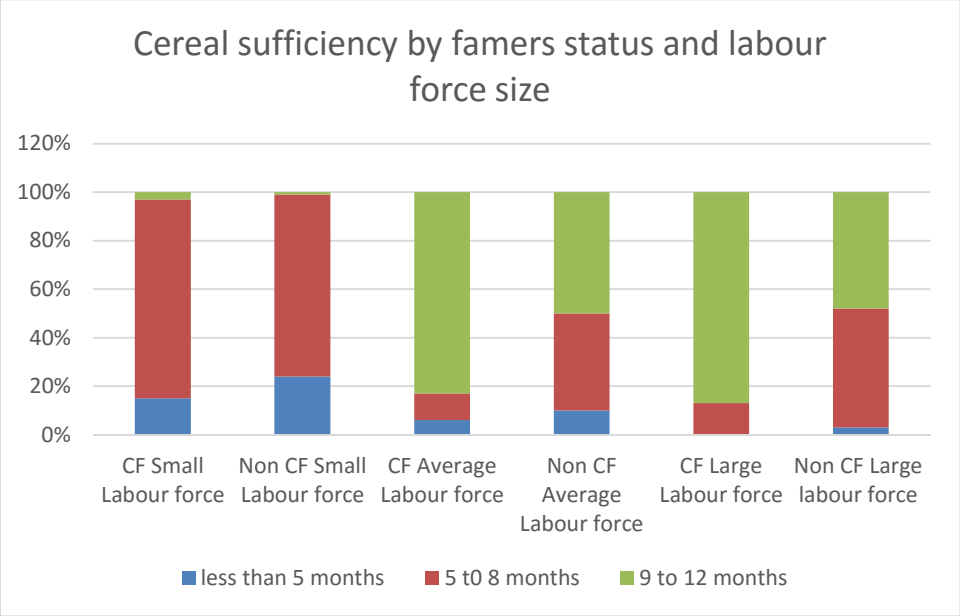

Figure 7: Cross tabulation analysis of labour size per household and CA yields.

The above table shows that cereal sufficiency of farmers improve with CA participation and increase in labour force size (labour units). the small labour forces constitute less than 3 able bodied members, average labour force has 5 able bodied and large labour force consist of more than six able bodied members.

Looking closely at cereal sufficiency analysis it shows that there is a strong relationship between labour force and yields despite the farming system. Small labour force households both CA and non-CA farmers indicates that 15% and 24% respectively had cereals which last them less than five months per year after harvest. This resembles a high degree of food security since households food sources are mainly from own harvest. This shows that the greater part of the year (more than seven months) the households will be food insecure. Meaning there will be need of getting cereals from other sources besides own harvest for instance food aid, donations, gifts and assets disposal. There sources are usually unpredictable and unreliable, hence they will be exposed to food crisis.

According to food security main pillars, food sources should be stable. Therefore, unreliable food sources are a sign of food insecurity. However, looking at the statistics it is quite evident that CA farmers are better off as compared to non-CA despite labour force. Under small labour force only15% of them spent less than five months consuming own harvest as compared to 24% of non-CA farmers. About 82% of the CA families with a small amounts of labour as compared to 75% of non-CA are able to spent at most eight months consuming own

harvests. Notably, 87 % of CA households characterised with large labour force are food secure as compared to 48% of non-CA farmers. This category is referred to as food secure since they are able to harvest and access cereals from own fields throughout the year.

According to Lungowe et al (2011), CF's high labour obligation needs may be addressed by developing machinery that use animal traction. Marongwe 2011, observed that some financing organisation prefer funding resource-endowed farmers with mechanisation equipment such as tractors leaving poorly resourced farmers fending for themselves yet if such farmers are supported to buy CA equipment there would be a big reduction in their labour requirements.

Figure 8: Ephraim Matambo of Chisina 3(ward 25), a lead farmer in Katizandima village who hosted PRP/CIMMYT exploratory CA trials in Gokwe South District

In one of the significant change stories EsiaMpofu of Njelele 2(ward 15) of Gokwe South District revealed that "Being CA lead farmer in Ziome village I discovered that the first two years it was difficulty to attract farmers to CA groups because there was a lot of labour required particularly during land preparations'' says EsiaMpofu. In his village they ended up forming farmer cluster working groups which proved to be effective in reducing labour requirements since farmers were carrying out land preparations in groups rotating household's plots. In the same village of Ziome after three farming seasons of practising CA and its benefits were quite evident it attracted more farmers. EsiaMpofu has this to say " …after farmers realised the higher yields from CA it attracted more farmers and majority of them are getting more than enough for consumption from a small piece of land……which is manageable with a small amount of money for inputs".

All interviewed CA farmers mentioned mulching as one of challenging tasks in practising CA. Maize stover is a supplementary livestock feed during winter and as such little is left for the fields. Key informants for example AGRITEX officers and local leaders revealed numerous reasons linked to mulching glitches. These include low biomass production, termite's problems, alternative use of crop residue like animal feeds, domestic fuel, construction e.g. thatching and fencing, burning of residue as a traditional means of

controlling weeds, pests, insects and rodents. According to Steiner, 2002 permanent soil cover is the heart of conservation tillage. Mulch is of paramount importance in reducing surface run-offs, improving rain water infiltration, suppressing and controlling weed growth, etc. (Hobbs, 2007; FAO, 2008; Giller et al., 2009).

During MSC story collection exercise, Ephraim Matambo of Chisina 3(ward 25) acknowledged that since he started CA in 2005 when the farming system was being promoted by Concern Worldwide, mulching was one of the major problems which negatively affected the adoption of the technology.On how to keep crop residue the lead farmer mentioned that it used to be problematic mainly due to free grazing. At village level together with traditional leaders they established binding by laws where there established controlled grazing system. "Here in Katizandima village we introduced a controlled grazing farming system where the traditional leaders allocated a piece of land for livestock. Now farmers are able to leave crop residue in their fields throughout the year. However, farmers are allowed to take part crop residue so that they are able to feed own livestock at the peak of summer season……..." saidEphraim Matamba.

In line with mulching coupled with no or minimum tillage has potential to increase substantially Soil Organic Carbon (SOC) (Govaerts et al. 2009). Nevertheless, there is consensus that consistent and sufficient inputs are the major determinants of SOC changes in the soil rather than tillage type (Chivenge et al. 2007). However, mulching mulch provides soil cover which upsurges infiltration at the same time it reduces run-off and soil loss specifically on a low slope since the concept is less effective on steep terrain (Adekalu et al. 2007). According to Rusinamhodzi (2015), carbon increases are accrues over time if the amount of mulch retained is more than that degenerated by the oxidation process.

Crop residues have low thermal conductivity such that it reduce soil temperature for optimal germination and root development particularly in hot environment (Lal 1978; Riddle et al .1996).Soil cover insulates the soil surface and increase resistance to heat and vapours transfer which result in increased soil water availability (Hatfield and Prueger 1996; Dexter 1997; Cook et al. 2006). In agreement to this notion, Rusinamhodzi (2015) added that mulch intercepts rainfall energy and reduces erosion.

In short seasoned areas characterised by low-intensity rainfall, mulching may reduce soil water recharge; this could be essential in arid zones because it can be intercepted before it recharges the topsoil (Sadler and Turner 1993; Savabi and Stott 1994). In addition, it has also

been discovered that the crop residue thickness has a direct effect on total interception of rainfall (Savabi and Stott 1994). Thus, crop residues application is not always positive and may be unfavourable to crop productivity for instance in humid areas. In cereal-based systems which dominate the tropics, most crop residues are derived from maize, millet and sorghum, which are rich in lignin and have high carbon/nitrogen ratios that are generally greater than 60 (Cadisch and Giller 1997; Handayanto et al. 1997). The positive benefits and effects of mulching are site specific hence in promoting CA application of mulch should be in line with prevailing ecological conditions.

Rusinamhodzi (2013) reported that most farmers preferred to feed crop residues to cattle and use manure for crop production in the same site. This is a common practice to cattle owners and under a mixed type of farming. This conclusion is not universally relevant hence it might not be justified conclusively to let farmers feed livestock with crop residue then use manure in crop farming. Based on these observations, some authors have concluded that CA would only fit in a limited set of socio-ecological niches in Africa, which is dominated by mixed crop-livestock systems (Giller et al., 2009, 2011; Andersson and Giller, 2012).

Contrary to the above notion, in Western Kenya, surface mulching had no effect on maize grain yield during the short rains, while quantities of maize stover applied as surface mulch in excess of 1 t/ha did not improve maize grain yield during the long rains (Baudron et al., 2013). Similarly in Melkassa, quantities of maize stover applied as surface mulch in excess of3 t ha−1 did not improve maize grain yield (Baudron et al., 2013). This suggests that (1) soil mulching does not always improve maize grain yield, and (2) when soil mulching is beneficial, maize grain yield does not increase linearly with the quantity of surface mulch applied. These results agree with the ones of Larbis et al. (2002) who found that increased residue retention resulted in increased crop yield up to a retention rate of 50%, but that further mulch retention did not improve crop yield significantly. Therefore, the target of30% soil cover often used in CA (Erenstein, 2003) may not lead to the most profitable crop residue allocation. The target originated from the US Corn Belt Region, a region that cannot be compared to other regions like Africa (Blanco-Canqui and Lal, 2009). There-fore, there is a need to understand the site-specific crop response to mulching, from which appropriate recommendations can be formulated.

The importance of soil cover under CA farming practice is strongly believed to be the basis of CA (Kassam et al., 2009). On the other hand, ploughing of fields has been viewed as the main cause of soil degradation and as 'an enemy of sustainability' (Marongwe et al 2011). Therefore, minimum tillage and mulching, reduces soil water loss from runoff and evaporation (Rockström et al., 2009; Thierfelder and Wall, 2009) may result in more efficient use of rainfall by the crop and yield stabilization, particularly in dry areas (Friedrich,2008; Erenstein, 2002, 2003). CA enables agricultural soil and landscape to be treated as living biological entities in which soil biota and their symbiotic relationships with root systems are encouraged while maintaining improved and efficient soil-plant-moisture-nutrient relationships (Jat et al., 2014).

Although some of the concepts of CA are controversial but the benefits of minimizing tillage has long term benefits since this enhances organic carbon in soil. This is complemented by mulch in improving water caring capacity. The idea of the importance of water conservation was supported by CAA, 2007 who states that increased water stress is predicted to be a result of climate change in many dry lands, thus management of water resources is a key issue in climate change adaptation. Boosting soil carbon enhances infiltration and moisture retention, improving water availability on site (Cowieet, al., 2011). This might be done through conservative farming systems like CA.

Poor farming methods have adversely contributed to climate change although combustion of fossil fuels is on top of the list. Poor farming methods include over-cultivation, overgrazing, deforestation, and poor irrigation practices, that directly or indirectly lead to loss of vegetation and declining soil quality. These same land management practices reduce biodiversity and ecosystem function through loss of habitat both on agricultural land such as through land-clearing, and in conservation areas due to indirect effects, such as through salinization of catchments (Hodgson et al., 2004; CAA, 2007). Integrating role of soil carbon plays a central role as an integrating factor in processes leading to, and management of, climate change, desertification and biodiversity loss (Lal, 2004). Soil organic carbon is derived from organic matter inputs, largely from leaf litter and root decay which would be boosted by crop residue under CA farming system. The above view is endorsed by Schimel et al., (1994) who pointed out that Soil carbon stocks reflect the balance between organic matter inputs and losses due to decomposition through action of soil fauna and microbes and physical export by leaching and erosion. The idea was supported by IPCC, 2006 who

concluded that carbon stocks in dry land soils tend to be around half that of soils in moist environments in the same temperature regime due to moisture stress.

Under certain circumstances, mulching may lead to yield penalty (Palm et al., 2001; Zibilske et al., 2002). In high rainfall areas, mulching may exacerbate water-logging (Rusinamhodzi et al., 2011). Conversely, in areas receiving frequent and small amounts of rainfall, mulching may reduce water infiltration as rainwater is intercepted by the mulch, temporarily stored, and subsequently lost to evaporation (Cook et al., 2006; Kozak et al., 2007). This justifies the fact that CA is site specific hence rigidity on core principles avoided since they are not universal applicable.

In areas characterized by periods of prolonged drying (e.g. where a distinct rainy season is followed by a distinct dry season) surface mulch may facilitate water flow from the soil to the atmosphere through capillarity, by maintaining the topsoil wetter for a longer period of time, and increasing the evaporation rate compared with a bare soil (Ungerand Vigil, 1998). In areas where mulching leads to yield penalty and/or where the quantities of crop residues available for mulching are too small (due e.g. to low crop productivity), minimum-tillage with no mulch may still improve water balance and short-term crop productivity if surface rugosity is purposefully increased. In the semi-arid area of Ethiopia, strip tillage was found to result in significantly higher maize yield and lower surface runoff compared with conventional tillage systems (Temesgen et al., 2012). For hand-hoe based systems, planting basins have been shown to increase soil moisture content compared to conventional ploughing in Zimbabwe and Zambia (Mupangwa et al., 2008). In addition to these tillage practices, a variety of structures – such as contour bunds, grass strips, pits, furrows, dikes, and terraces – may contribute to soil and water conservation at plot- and landscape-level in the absence of surface mulch (Vohland and Barry, 2009).Thus, the availability of crop residues for soil mulching may not be as limiting for the wide adoption of CA in Africa as suggested in previous analysis (e.g. Giller et al., 2009, 2011; Andersson and Giller, 2012). Indeed, crop yield does not appear to increase linearly with increasing quantities of surface mulch in many situations, implying that crop residues could be shared between soil mulching and livestock feeding without negative consequence for crop productivity. Under other circumstances, mulching may not be desirable and thus competition for residue between CA and livestock may not exist. Baudron et al., 2013 concluded that, ‘CA without mulch’ may

yield a number of benefits for smallholders, including cost-and or labour-savings during land preparation.

In the review of adoption of CA worldwide, Knowler and Bradshaw, (2007) concluded that the transition from conventional tillage to CA cannot be explained by universally significant factors although financial viability and social capital seem to be the two key factors. In addition the technical problems in its implementation, the promotion of CA as an indivisible package and limited involvement of farmers in the designing of CA alternatives leads to partial adoption of CA (Edquist, 1997; Gowing and Palmer, 2008; Giller et al., 2009). Therefore, rigidity of CA on core principles should be relaxed for instance farmers should be free to select and modify components they are interested with not imposing the technology on farmers. Farmer should add value to the farming system in line with the context and specific environment they are living in.

Farmer group discussions during the survey showed that farmers were conscious of the long term benefits of mulching their fields. The challenge was how to balance crop and livestock farming since farmers' depend on livestock as a livelihood source, not only during drought periods but also for basic amenities. There is very high interdependence between crop and livestock production among small scale farmers. In Zimbabwe livestock is used as draught power, meat and to produce organic manure. There is evidence suggesting that aspects of conservation agriculture can conflict with some of the livestock production practices (Valbuena et al, 2012).

Multi-purpose utilization of crop residue was also depicted by Baudron et, al., 2013 who focused on livestock feeds. Feeding crop residues to livestock is common and an alternative use among other uses like fuel and construction in developing nations, where 75% of the milk and 60% of the meat are produced in mixed crop-livestock systems (Herrero et al., 2010; Valbuena et al., 2012). In support of this view Jaleta et, al., 2013 crop residue use for soil mulch and animal feed are the two major competing purposes and the basic source of fundamental challenge in conservation agriculture (CA) where residue retention on farm plots is one of the three CA principles. In mixed crop–livestock systems, use of crop residues as livestock feed is one of the major interactions between crop and livestock production (McIntire and Gryseels, 1987; Latham, 1997; Gebremedhin et al., 2007; Erenstein and Thorpe, 2010; Moritz, 2010; Erenstein et al., 2011). In line with the importance of mixed

crop–livestock systems, Herrero et al., 2010 believed that it produce about half of the world food. Therefore, there should be a way of integrating livestock with promotion of CA farming system under such scenario.

Livestock plays a critical role within African context in households' food security and general livelihoods. Livestock ownership is one of important capital assets in African culture. Livestock production is a major component of the agricultural economy of developing countries. It contributes directly to food security through food production and indirectly through income generation from sales and draught power hiring. Livestock are therefore considered the living bank for many smallholder farmers and play critical a role in the agricultural production under a mixed farming system.

There is high potential of sustaining food security through the inclusion of fodder production in CA farming system particularly in a mixed farming system. Mupangwa and Thierfelder (2013) revealed that forage crops can be successfully produced in CA systems. There is high degree of complementarity and symbiotic relationships in mixed farming system, livestock and crop farming. In addition to crop residue, manure use as soil fertility management, draft power in land preparation and cultivation practices, and financing the purchase of inputs in crop production through livestock sale are other major sources of interactions between crop and livestock subsystems (Erenstein and Thorpe, 2010). Crop farming avails stock feeds for livestock and these linkages within a mixed farming system should be considered when promoting CA. If these dynamics are not considered, attainment of sustainable food security through conservation farming will be problematic in a mixed farming system.

In Canada it was discovered that perennial plants are among the most important contributors to soil and ecosystem health (Kunzig, 2011). This indicates that there is room of complementing CA with perennial crops as part of crop diversification. Such improvements of the farming system are crucial specifically in mixed farming system but adoption of CA practice is the entry point. In western Canada, integrating crop and livestock enterprises provides economic benefits (Brewin et al. 2014). There is high potential of sustaining food security through the inclusion of fodder production in CA farming system in Africa (Mupangwa and Thierfelder, 2013).

In view of this, future forecasts indicates that crop residue demand by the livestock sector in developing countries is unlikely to go down since meat and milk consumptions are projected to be more than double by 2050 (Thornton, 2010). A trade-off arises when one faces at least two objectives towards a resource that cannot simultaneously be achieved (Grimble and Wellard, 1997). Due to the multiple benefits livestock generates (Schiere et al., 2002; Powell et al., 2004;Rufino et al., 2006; Herrero et al., 2010; McDermott et al., 2010), mixed crop-livestock African farmers allocates the bulk of their crop residues to livestock at the expense of soil thus trading soil mulch for livestock (Valbuena et al.,2012). Gokwe South results were similar to this argument although mulching was also aggravated by free grazing system.

One of the short-term benefits of CA is directly linked to draught power specifically for the poor farmers without cattle for ploughing. With the advent of CA farmers are able to plant earlier which enables better use of seasonal rainfall, and increased rainwater conservation in the soil to effectively tide crop during drought periods (Rockstrom et al 2009). Prior to introduction of conservation agriculture, poor farmers without cattle tend to delay to plant since livestock owners will start to plough own fields first exploiting first effective rains. Therefore, poor households would not be able to maximize on first effective rains. Late planting has negative effects on the ultimate yield levels. With the introduction of CA farmers are able to plant well on time using first effective rains. These factors were viewed as immediate benefits of CA by farmers.

Similar opinion was also shared by previous research findings who concluded that CA may also generate a number of short-term benefits for farmers (Knowlerand Bradshaw, 2007; Rusinamhodzi et al., 2011). Reduction in machinery and fuel costs has been one of the major incentives for the large-scale adoption of CA in North America, South America and Australia (Kassam et al., 2009). Looking closely at why the concept was developed, there are different views for each specific region. For instance in developed countries like America and Australia CA was developed as a means to reduce operational costs as well as to curb excessive erosion. In Africa the same CA concept was introduced for different reason-food security. These disparities lead to non-homogenous impact of CA from one region to the other. While in developed nations the immediate benefits of CA is reduction in fuel cost in the less mechanized farming for example in developing countries like Zimbabwe, Mozambique, Kenya, Malawi and Ethiopia include planting on time. CA may enable early

planting, as the number of operations required to prepare the land are reduced (Haggblade and Tembo, 2003). Moreover, reduced soil water loss from runoff and evaporation (Rockström et al., 2009; Thierfelder and Wall, 2009) may result in more efficient use of rainfall by the crop and yield stabilization, particularly in dry areas (Friedrich,2008; Erenstein, 2002, 2003).

In attempting to assess contribution of CA in alleviating food insecurity, the researcher looked at contribution of CA farming system to food security. A modified HEA approach was used where main overall income sources were assessed with specific details for instance all resources of food for farmers were scrutinized. Farmers were not only categorized into two main groups-CA and non-CA farmers but also into groups of similar socio-economic base. The results show that main sources of food are own crop harvests, purchases, livestock products sells and casual labour for poor households as detailed below:

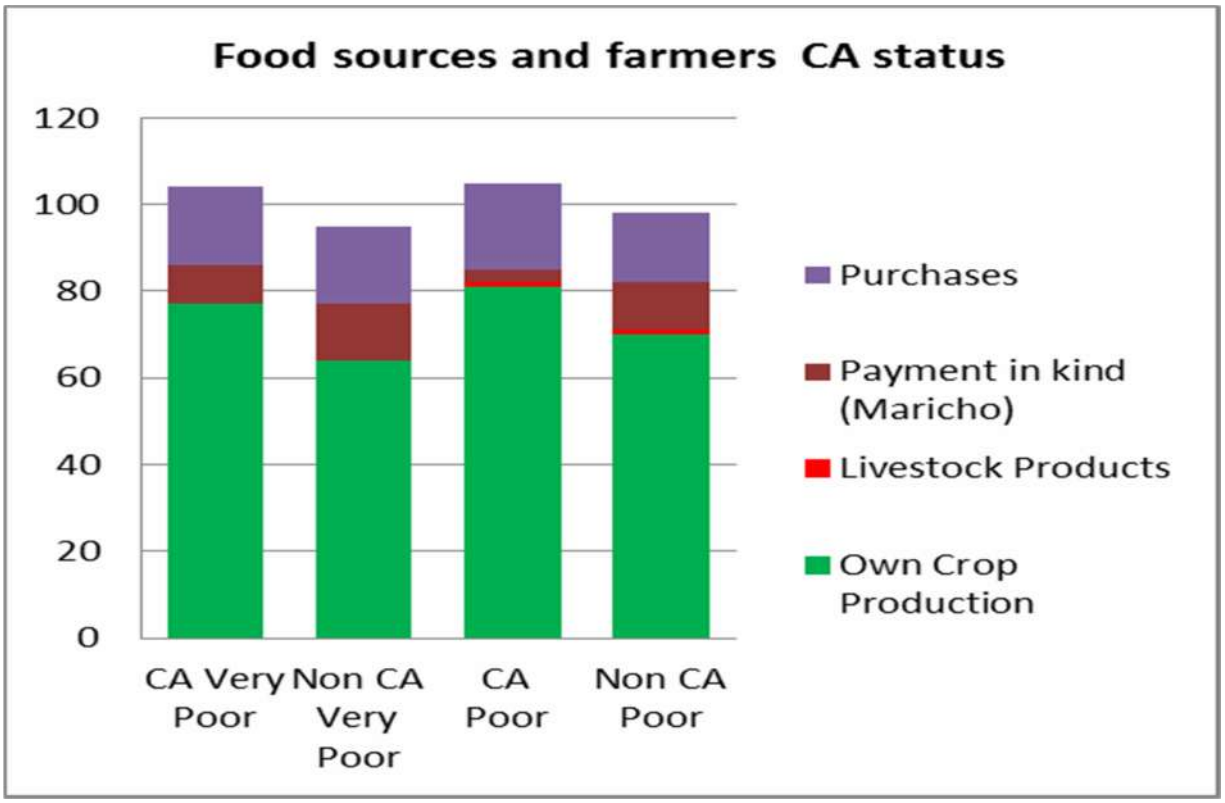

Fig 9: Farmer food sources

Own crop production is a major contributor to annual food requirements for households across all wealth groups and regardless of farmer's CA status. The reveals how important is crop farming in sustaining rural households in Gokwe South District. The contribution of own crops to annual households food requirements is high in CA farmers compared to non-CA as indicated in the graph above with CA very poor 77% and CA poor 81%. This shows that CA very poor farmer's get more of their food from own crop production as compared to non-CA very poor farmers. This is an indicator of high yield levels of CA farming system. This observation is in line with other scientist who list high yield production as one of the key benefit of CA (Thierfelder and Wall, 2010). These results resonates with the previous studies which indicates that CA systems resulted in yield increases for several crops, including maize, legumes, sorghum, cotton, sunflower, potatoes, finger millet, pigeonpea and cotton (Ngwira et al., 2012 and Rockströmet al., 2009).

In line with these results, similar observations were noted in exploratory trials in Malawi and Mozambique where CA plots proved to be better than farmer proactive for a period of over three years (Nyagumbo et al 2014). In separate long term research trials similar results were also observed in Malawi where crop rotation was depicted as the main contributor to higher yield than traditional farmer practice (Thierfelder et al., 2012).

In general, it was discovered that non-CA farmers failing to acquire enough food throughout the annual cycle as shown by total food sources being below 100%. This shows that CA farming system has potential of addressing food shortages in Southern Africa specifically in agro-based economies like Zimbabwe. Although food security is too broad and complex but accessing cereals throughout the year with own harvest with the greatest percentage is a proxy indicator of significant contribution towards food security.

Existence of casual labour as a source of food indicates that despite the fact that there are some improvements in food availability as shown by statistics, they are still food insecure. The argument is emanating from the fact that 'maricho' is not a stable livelihood source. Stability underpins the other three pillars of food security, availability, accessibility and utilization. In case of a shock like drought no one will be able to engage anyone to work hence instable. Apparently households are at various levels in terms of food access despite the fact that they are poor households. Non-CA very farmers are relying on casual labour as a source of money as compared to CA farmers. This is a pointer to the fact that CA has a positive contribution towards food security at household level. Therefore, farmers practising CA are better off than non-CA farmers as far as food availability and security is concerned.

Livestock ownership is not only important on dietary basis but is also brings stability in ensuring household food security. Households with livestock easily sell them in case of an adverse shock.

In attempting to assess main sources of household food or livelihoods farmers in the District were asked to rank the importance of various food sources mentioned. The main sources of food identified by farmers were own harvest, purchases, food aid and casual labour. Farmer ranked the most important source as number one less preferred as number two and the least common source as number three.

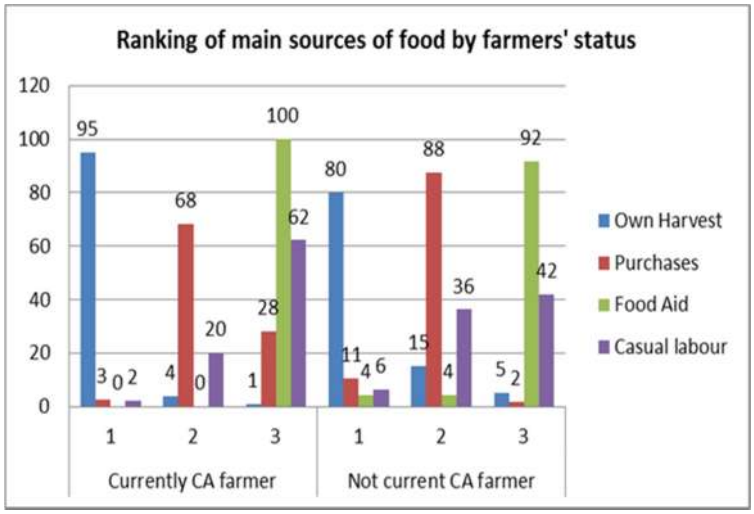

Figure10:Ranking main food sources

The results show a very huge difference between CA and non-CA farmers. In general CA sources of food are more stable as compared with non-CA. For example CA farmers are depend on own harvest as the main source of food with 95% of the interviewed farmers ranking it as the most common sources of food. There is few farmers who mentioned own harvest as the major source of food under non-CA farmers. This is a pointer to the fact that CA is positively contributing towards household food security mainly due to increased productivity as compared to other farming system. It also bring in stability on food sources since farmers are producing own food they are bound to be self-sufficient as compared to those other ways of accessing food like food aid.

Although food security is diverse since based on four different facets, own harvest under CA has potential in address key factors of CA. For instance own harvest addresses key parameters of food security which are centred on food availability, access, utilization and stability as detailed below:

Food availability-Field results shows that CA farmers are harvesting more yield as compared to other farming system. This shows that there is potential in CA farming system in availing food to farmers. CA result shows huge potential in addressing hunger in developing nations, although food security is not only concerned about availability but also sufficiency, safety and nutritious value.

Food access-Gokwe South results revealed that farmers are producing food for own consumption (subsistent farming). Hence farmer are accessing food produced from own fields. Assessing food security at micro level for instance at household CA has potential of alleviating hunger. When accessing food availability at a higher level than many factors are to be considered for instance infrastructure, socio-political access e.g. traditional rights to common resources and economic access (ability to generate income, purchasing power, and evolution of real incomes and food prices (FEWS NET, 2014).

Food utilization-One key factor of CA is crop rotation or intercropping of cereals and legumes for instance sugar beans, soybeans, round nuts, ground nuts etc. Integration of legumes in CA brings in dietary diversity to farmers. Legumes production at community level does not guarantee household utilization. However, contribution of CA in crop diversity and introduction of legumes in farming system is a positive step in addressing food deficiency.

Food Stability - In Gokwe most of CA farmers are getting the bulky of food requirement at household level from own fields hence the source to some extent is stable because they are not depending on external institutions like food aid. There is a ray of hope in resolving food crisis in developing countries through CA although climatic conditions are always unpredictable to assure stability.

Non-CA farmers ranked food aid 4%, purchases 11% and casual labour 6% as number one sources of food compared to 0%, 3% and 2% CA farmers respectively. This shows that main sources of non-CA farmers are unstable compared to CA farmers. This difference is attributed to different farming systems. Farmers practising CA are better off as compared to non-CA farmers. All interviewed CA (100%) farmers listed food aid as the least common source of food but this is contrary to non-CA farmers since some of them mention it as number one in provision of food.

4.1. CONCLUSIONS AND RECOMMENDATIONS

Chapter five of the research thesis focuses on conclusions and recommendations based on survey findings discussed and presented in the previous chapters. Being the last chapter of the thesis it also looks at the future after the research analysis in terms what and is it to take forward. In other words, possibly solutions to the problem identified are presented in this chapter as well as conclusion statements.

The study findings revealed that CA has potential in addressing food scarcity in agro-based economies like Zimbabwe but there is need to consider environmental context. The results show that CA is 'site specific' and positive impact of it varies from one place to the other. CA is more appropriate in dry areas characterised by sandy soils. It was discovered that in humid clay soils for instance mulching would result in water logging. Under this environment conventional farming tend to be better since there would be poor yields under water logged farm lands. However, a significant increase yield increase under CA as compared to conventional practice was noted in the studies which give a ray of hope in addressing food insecurity problems in Africa. CA conserves resources for the future utilization for instance soil through reduction in erosion, nutrients and effective use of water specifically under rain-fed farm lands.

CA if practiced without herbicides it is 'labour intensive' as compared to conventional farming. This was quite evident for small scale farmers who use hand hoes for both basin formation and weeding. Use of herbicides in reducing labour requirements is one of the effective solutions under CA. One may wonder if herbicides use is so important why is it not part of the three main principles of CA. It was discovered that mulched fields are more difficult to weed as compared to bare fields usually under conventional farming.

Three main principles of CA, minimum tillage, crop rotation and mulching are not all universally applicable hence, it not ideal to promote the farming system as a package. As highlighted in the document mulching in humid and clay soils may lead to adverse effects of water logging. Crop rotation is not also possible for farmer very small arable land for instance less than 0, 3 ha since there is no adequate space for crop rotation. Under this scenario it is prudent for the farmer to intercrop as compared to crop rotation.

Multi-purpose of crop residue is one of the major problems linked to CA specifically under a mixed farming system. High competition on the use of crop residue between mulching and

livestock feeding under a mixed economy is one of the biggest challenges in promotion of CA farming system. There is need of integrating CA and livestock feeds within the promotion of CA. This is critical in agro-based African economies since livestock is of great importance in complementing crop farming in ensuring food security.

4.2 Recommendations

Appropriate CA Promotion strategies: In Zimbabwe promotion of conservation agriculture was linked to humanitarian assistance supported by NGOs. They used humanitarian approaches as way a of attempting to sustain food aid projects so that poor farmers will be able to be productive in future. This lead to promotion of CA as input-driven which was not effective in that farmers were only motivated to adopt temporarily during the life span of the projects. Under any emergency situation people will be focusing on immediate needs for instance food hence it is incongruous for introducing CA which has long term benefits in an emergency mode. Under this circumstance there will be a mismatch in terms of preference between development practitioners and community members.

Developmental approached should be used in promoting CA. Under this approach farmers would not be viewed as objects since they play a critical role in the farming system. Farmers will be recognised as one of the main stakeholders hence their input should be highly considered. Farmers will be given leeway to modify the farming system for instance blending it with indigenous knowledge. In addition to this, farmers will have room to fully under understand both short and long term benefits of the technology. Sustainable developmental approaches will be of paramount in promotion of CA since the technology is key for immediate yield increase whilst preserving the environment for future. Under developmental approaches CA will sustainably promoted since farmers will not be lured by provision of agricultural inputs. The other advantage of developmental approaches is the holistic concept in targeting in that CA would not be stigmatized or associated with poverty as was in the case the way CA was introduced and promoted in Zimbabwe.

Relaxation of CA principles since they are not universally applicable: Conservation agriculture farming system should not be promoted as a package where the concept will be underpinned on three fundamentals, minimum tillage, crop rotation and mulching. According to the current definition of CA, if one of the three is missing it seizes to be CA. Research results revealed that crop rotation and mulching only yield positive results benefits if to specific agro ecological conditions. They are not universal beneficial to farmers therefore

they cannot rigidly promoted worldwide. It is highly recommended for the local farmer to choose what they like to adopt or to modify. In this regard conservation agriculture should be promoted as intensification farming or other terms like 'climate smart' agriculture which will not be restricted to three fundamental principles since they are not applicable in the world over.

Livestock integration in a mixed farming system: Considering the importance of livestock to African economy and the conflicts between CA and livestock in terms of crop residue utilization. In a mixed farming system livestock plays a pivotal role in various forms for examples provision of proteins, draught power, manure for crop farming, selling of livestock to access inputs and other basic amenities. Contrary to these benefits there is a high competition between livestock and crop farming. Crop residue is used as mulch in CA but on the other hand under a free grazing system mulch is freely consumed by livestock. Some farmers prefer feeding livestock to mulching.

Under this scenario it is integration of livestock farming will be important within conservation agriculture. This might be done through inclusion of fodder crop for livestock within CA farming system. Fodder production might be part of the crop rotation with cereal and legumes. This will reduce competition on crop residue between mulching and livestock. Again, the approach should not homogeneous on earth it should be up to the farmer to make ultimate decision and choice. For instance in most part of Malawi they do not keep livestock mainly cattle hence the integration component might not be relevant to them. In agro ecological zones with heavy clay soils and high rainfall areas impact of mulch might be disastrous therefore mulching should be highly discouraged under that situation.

Government support of Conservation Agriculture: Although under this study government of Zimbabwe was supportive in forms of giving NGOs space for promotion of CA through partnering with Ministry of Agricultural departments. In support of such innovative farming systems, Government of Zimbabwe should hasten capacity building of staff on CA and inclusion of this within agricultural tertiary institutions and schools for future generation. The farming system should be blended within the formal training and educational curriculum. The current situation is that CA is not yet part of the formal educational system although Government already had some plans of integrating CA in colleges and schools in future.

Training of CA is being contacted by NGOs, research and ecumenical institutions in Zimbabwe. These institutions include Foundation for farming (Former River of life),

CIMMTY and ICRISAT. Agricultural officers are being trained by these institution after completion of their studies hence the fact that CA is not part of formal education it is difficult to be considered seriously. Inclusion of CA within formal educational system will sustain the future and it would be easy to standardize concepts in schools and tertiary institutions.

In assuring sustainable community food security there is need of considering the critical role played by markets. Strengthening of local markets is critical for farmers to access both input and outputs marketing facilities. CA system works better with high quality seed and use of fertilizer. Therefore, agricultural inputs should be readily available at community level. It is also vital to ensure functional outputs markets. Farmers should have readily available market to sell their products. In marketing information sharing and flowing is very critical in that farmers are supposed to know availability and prices of products they are looking for as well

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