FACTORS CONTRIBUTING TO DISADOPTION OF CONSERVATION AGRICULTURE AMONG SMALLHOLDER FARMERS IN PETAUKE, ZAMBIA

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DECLARATION

I Estone Jiji Habanyati (512802000) declare that this dissertation is my own work, and that it has not been previously submitted for a diploma, advanced diploma, degree or master's degree to the University of Zambia (UNZA) or any other university in the world. All the sources of previously published work referred to have been acknowledged.

Signature: …… Date: ……

CERTIFICATE OF APPROVAL

This dissertation by Estone Jiji Habanyati is approved as a partial fulfillment of the requirement of the award of the degree of Master of Science Environment and Natural Resources Management of the University of Zambia.

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DEDICATION

To my Wife Matilda Phiri, Son Miyanda Habanyati and Daughter Ellen Habanyati for their patience and sacrifice during my period of study.

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ABSTRACT

Conservation Agriculture (CA) has widely been promoted by government through the Conservation Farming Unit of the Zambia National Farmers Union and non-governmental organizations such as Land Management and Conservation Farming Project, the Golden Valley Agricultural Research Trust, the Institute of Agricultural and Environmental Engineering Project, the Cooperative League of the USA, World Vision and various donors to address problems of low crop yields and food insecurity among smallholder farmers in Zambia. Despite the increasing interest and funding in CA, its disadoption among smallholder farmers is common especially after the end of CA projects. Several studies have been undertaken on the adoption of CA but few studies have been conducted on the factors that lead to disadoption of CA. Thus, this study identifies factors that contribute to disadoption of CA and opportunities for reducing disadoption among smallholder farmers in Petauke District of Zambia.

The data was collected from 92 randomly selected smallholder farming households using questionnaires; in-depth interviews with seven purposively selected key informants and four focus group discussions. Qualitative data was analyzed by thematic and content analysis and quantitative data was analyzed by chi-square and a binary regression. Results show that 29 percent of smallholder farmers disadopted CA. CA basins were the most disadopted due to their labour intensiveness. The four most commonly cited factors leading to disadoption of CA as reported by smallholder farmers are lack of farm transport for manure (31 percent), high labour demand (25 percent), lack of adequate knowledge in CA (16 percent), and lack of free incentives (16 percent). Chi-square analysis showed significant association between each of the following factors with disadoption of CA: labour intensity; lack of access to free incentives; lack of farm transport for manure and poor local CA leadership. Regression results showed that lack of transport for manure; lack of adequate knowledge in CA; location and lack of free incentives (material items given) contributed significantly towards increased likelihood of CA disadoption at 0.05 level of significance. From the smallholder farmers' perceptions, options for reducing the disadoption of CA were increased access to free incentives including herbicides; enhance CA training; increase access to transportation of manure; provision of CA equipment and good local CA leadership.

Thus this study concludes that most of the factors that influence disadoption involve the attitude of the farmers, dependency on incentives, labour constraints, poor rapport between the local CA leadership and smallholder farmers, and lack of essential CA assets. This study recommends that CA promoters, donors and government should help smallholder farmers to become self-reliant, reduce their provision of free agricultural inputs and enhance CA trainings to smallholder farmers so as to minimize disadoption of the technology. Introduction of CA in communities should be based on scientific evidence rather than material incentives.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Throughout the world, and particularly in South Asia and Sub Saharan Africa (SSA), many of the poorest people are smallholder farmers and agriculture is the major source of income in these regions accounting for 34 percent of Gross Domestic Product (GDP) and 64 percent of the labour force in SSA (Jack, 2011). Jack (2011) further observes that food production and crop yields in SSA have lagged behind those of Asia. Zambia is one of the countries in SSA whose agriculture is experiencing a reduction in crop yields (Food and Agriculture Organization Corporate Statistical Database [FAOSTAT], 2011). Smallholder farmers in Zambia are very vulnerable to increasingly extreme climatic shocks such as droughts and floods (United Nations Fund for Population Activities [UNFPA], 2011). Reduction in crop yields is one of the factors that led to about 44 percent of the Zambian population to experience food deprivation in 2009 (UNFPA, 2011).

Globally, the necessity of increasing food production in response to the reduction of crop yields brought about the so-called 'Green Revolution' during the last half of the 20thCentury, (Sumberg *et al.,* 2012; Pingali and Rosengrant, 1994). In the 1960s, partly because of the rapidly rising population, Zambia's agricultural output never reached the point of meeting domestic food requirements and in some years the crop yields reduced (Worldmark Encyclopedia of Nations [WEN], 2007). In response to the reduction of crop yields among smallholder farmers in Zambia in the 1960s, the Zambian government adopted Green Revolution agricultural practices as a way of resolving the increasing food demand from an increasing population (Eilitta, 2006). 'Green Revolution' is an industrialized agriculture system which has been highly successful in raising crop yields. During the Green Revolution, crops were raised through the maximized usage of fertilizers and pesticides. In the 1970s and 1980s, smallholder farmers rapidly increased their use of hybrid maize seed and fertilizer. Maize yields rose impressively in countries such as Zimbabwe, Zambia, Kenya, and Malawi (Govereh *et al.,* 2008). However, a fully-fledged Green Revolution has not happened in Africa especially in SSA. A common narrative on the underlying causes for the failure of the Green Revolution in SSA is the lack of irrigation facilities and that rainfall is very unreliable, while soil fertility is also very low: 'the unlucky fate of Africa' (Voortman, 2013).

By the 1980s, there were concerns being raised about environmental and health consequences of the Green Revolution such as water pollution from fertilizer use, water logging,

biodiversity loss and human poisoning associated with pesticide use and land degradation (Loevinsohn, 1987; Pimentel and Pimentel, 1990; Pingali and Rosengrant, 1994). The United Nations Convention to Combat Desertification (UNCCD), (2005:7) defines land degradation as "the reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rain fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns." According to Lal and Okigbo (1990:58) land degradation "is the decline in soil quality caused through misuse by humans and results in deterioration of soil's life support processes and decline in its capacity to produce food, feed, fiber and fuel."

Land degradation has reportedly occurred in Zambia as a result of unsustainable farming practices such as shifting cultivation; and the use of Green Revolution technologies and practices such as, continuous mono-cropping and over-grazing, use of heavy machinery for cultivation, and use of mineral fertilizers (GRZ, 2002; Eilitta, 2006; Loevinsohn, 1987; and Govereh *et al.*, 2008). These practices are reported to be unsustainable due to their extensive land degradation effects (GRZ, 2002). Land degradation is severe in the southern half of the country that covers the Central, Eastern, Southern, Western, and Lusaka Provinces of Zambia; and has resulted in low land and crop productivity, water logging, biodiversity loss and human poisoning associated with pesticide use and land degradation (GRZ, 2002; Pimentel and Pimentel, 1990; Pingali and Rosengrant, 1994). Low land and crop productivity resulting from land degradation leads to reduced availability of food at household level (Umar, 2012). In response several sustainable agricultural systems have been promoted to improve soil health and water conservation such as conservation agriculture as a way of encouraging sustainable land management (Chiputwa *et al.*, 2011). Quisumbing *et al.*, (1995) add that sustainable production of food is very important for food security.

Options for addressing land degradation and household food insecurity are as many as their corresponding causes (FAO, 2011a). These options include agro-forestry, institutional reforms and climate smart agriculture systems like conservation agriculture (CA) (Nyanga, 2012, FAO, 2011a and Ramakrishnan, 1993). Conservation Farming Unit (CFU) (2006) and FAO (2006), claim that CA provides farmers with a means for optimizing their yields and profits while maintaining a balance between agricultural, economic and environmental benefits on a sustainable basis. Despite the great alternative that CA is espoused to be for many smallholder

farmers, there seems to be widespread disadoption (Haggblade and Tembo, 2003; Wandel and Smithers, 2000; Gukurume *et al.*, 2010). Wandel and Smithers (2000) reported that despite getting information and financial incentives to motivate adoption of conservation agriculture, many farmers rejected adoption due to the many constraints they encounter. Haggblade and Tembo (2003:18) add that, "anecdotal evidence from our survey indicates that after a period of time, some farmers disadopt the practices." In a similar vein, Gukurume *et al.,* (2010) observed that smallholder farmer participation in CA is more cosmetic than genuine, since they participate out of fear of disappointing the NGOs that have been aiding them for a long time during times of need. Thus this study examines factors leading to disadoption of CA and options for reducing disadoption from smallholder farmers' view point.

1.2 Statement of the Problem

Despite the increasing interest and funding in Conservation Agriculture, there is disadoption of the agricultural system at individual/household level in Petauke. It seems that the strategies used to make farmers continue with CA are ineffective yet resources are increasingly being spent. Adoption levels are high among smallholder farmers during CA project implementation phases, but at the end of CA projects disadoption is common among smallholder farmers. Disadoption of CA can constrain the development of a sustainable agricultural system for smallholder farmers in Zambia. Furthermore it compromises the effectiveness of the foreign aid on which CA promotion depends on. Ultimately, development initiatives such as CA will not lead to environmental sustainability, reduction in food insecurity and reduction in poverty at large. It is thus important to identify factors leading to disadoption of CA and options for reducing the disadoption. A number of studies have been undertaken to assess factors leading to the adoption of CA but few have been done on the factors that lead to its disadoption. Thus this study adds to the few studies investigating the disadoption of CA among smallholder farmers.

1.3 Aim

To assess CA disadoption among smallholder farmers in Petauke, Zambia.

1.4 Research Objectives and Research Questions

The objectives and research questions of this research are:

1. To identify the factors that contribute to disadoption of conservation agriculture among smallholder farming households in the study area.
   (i) What are the disadoption rates in the study area?
   (ii) What socio-economic factors contribute to disadoption of CA?
2. To identify opportunities for addressing the challenges faced by smallholder farmers that lead to CA disadoption in the study area.
   (i) What are the options for reducing the disadoption of CA in the study area?

1.5 Research Hypothesis

(i) There is a significant association between CA disadoption and socio-economic factors such as lack of access to relief food, lack of ownership of CA tillage equipment (*chaka* hoe) and assets (cattle), low education levels attained, low CA training attendance, lack of access to transport to transport manure, lack of access to CA incentives, high CA labour demand and poor local CA leadership.

1.6 Significance of the Study

In order to have a more effective impact on promoting widespread adoption and continuity of CA, concentrating on factors that lead to disadoption can be fruitful and potentially lead to increased returns on the resources spent on CA promotion as well as the increased agricultural productivity associated with the correct and continued practice of CA. The information obtained from this research could be of help to agricultural policy makers, agricultural decision makers, donors, promoters of CA and the farmers on how disadoption levels can be reduced and simultaneously increase CA adoption rates. The findings from this research will also be an addition to the body of knowledge on the factors that lead to disadoption of CA.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

According to CSO (2012:354) "agriculture is the mainstay for the majority of rural households in Zambia with 2,513,768 households engaged in the sector." Zambia's agriculture is experiencing the effects of climate change especially in the reduction of crop yields (FAO, 2000). Levels of food insecurity are quite high with 44 percent of the Zambian population experiencing food deprivation annually (FAOSTAT, 2011; UNFPA, 2011). In response to challenges of food insecurity, CA has increasingly been promoted as one of the options for addressing food insecurity in Zambia since the 1980s (CFU, 2006 and FAO, 2011a).

CA, as applied in Zambia, involves a package of several key practices: dry-season land preparation using minimum tillage systems; crop residue retention; seeding and input application in fixed planting stations; and nitrogen-fixing crop rotations (Haggblade and Tembo, 2003). CA is argued to be one agricultural system that can be used to increase food production during periods of rainfall variability because of its ability to withstand climate change effects (Hobbs *et al.,* 2008). It is further claimed that CA offers benefits of increased soil organic matter, improvements in water harvesting, reduction of the risk of crop failure, increased and stabilized yields, reduction in soil erosion, improvement in soil structure, reduced pests and diseases, reduced weed germination, and increased productivity which translates into food security at household level (Derpsch *et al.,* 2010; Li *et al.,* 2011). According to CFU (2006) and FAO (2006), CA provides farmers with a means for optimizing their yields and profits while maintaining a balance between agricultural, economic and environmental benefits on a sustainable basis. Norman *et al.,* (1997) contended that CA can help farmers survive in land degraded areas because it works with nature. CA reduces the cost of purchased inputs by utilizing farming techniques that incorporate biological cycles and the farmers' knowledge and skills (Pretty and Hine, 2001). It also helps small farms to continue operating through diversification and increased profits from alternative ways of marketing, such as value added products, or direct marketing strategies (e.g. farmer markets and community-supported agriculture (Fazio *et al.,* 2003; Horrigan *et al.,* 2002). These espoused potential benefits of CA have led to an increase in the promotion of CA by farmers unions, international development agencies and national governments. As CA has been diffusing in different areas, its adoption rates have been varying dramatically across agro-ecological

regions, provinces and even within individual districts (Haggblade and Tembo, 2003). Even within a given high-potential CA zone, adoption rates differ considerably.

2.2 Background of CA in Zambia

There are two main systems of CA that are promoted in Zambia: hand hoe based CA utilizing the *chaka* hoe (Figure 2.1 (a)) and ripping using animals [animal draft powered ripping (ADP ripping)] CA referred to as (ripping) (Figure 2.1 (b)). A third system, tractor ripping is not common.

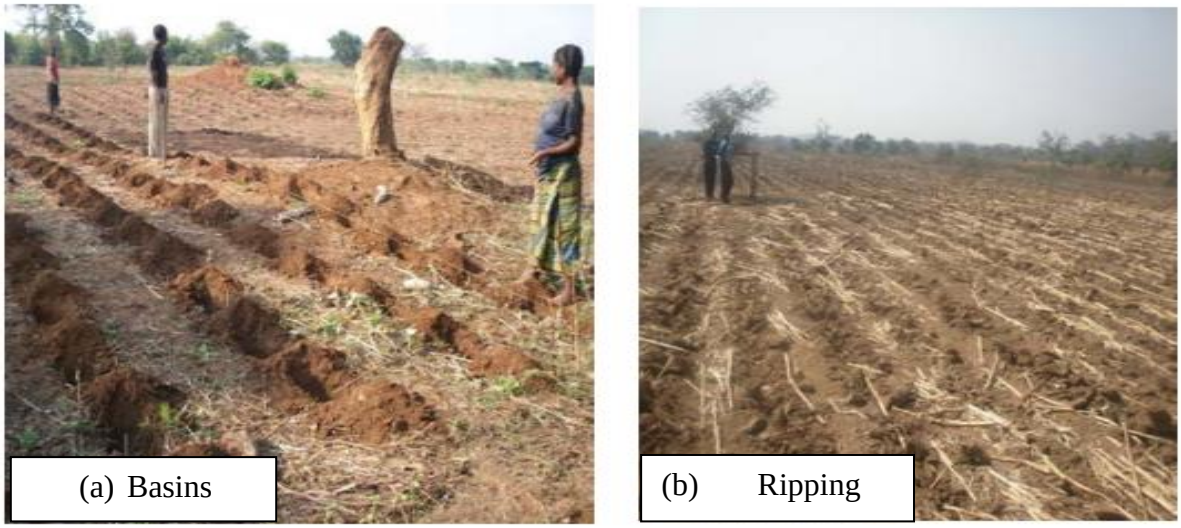

Figure 2.1: *CA tillage systems commonly adopted by smallholder farmers in Zambia*
Source: Nyanga (2012)

Hand hoe based CA involves the use of a *chaka* hoe. A *chaka* hoe has an elongated thick strong blade and a long handle as compared to a traditional hand hoe. These features of a *chaka* hoe account for its heaviness relative to traditional ones. Hand hoe based CA involves digging of CA basins spaced at 0.7 meters along the rows and 0.9 meters between rows (CFU, 2009a). Recommended dimensions of the basins are 30cm length, 15cm width and 20cm depth. This is equivalent to tilling 7 percent of the land (Umar *et al.*, 2012). Crop residues and other vegetative matter are retained in the area between basins. For improved accuracy and precision in the layout of grids of basins, CFU advises farmers to use a teren rope, with markers of knots or small metallic plates spaced at 0.7 meters. Farmers tie one end of the teren rope to a peg at one end of the field and the other end of the rope to another peg at the other end of the field (Nyanga *et al.*, 2012). On the contrary, hand hoe based conventional agriculture involves tillage of the whole field using a traditional hand hoe or making ridges

resulting in maximum soil disturbance. A conventional mould board plough is used under ADP which also results in maximum soil disturbance.

The second system of CA is the animal draft power based CA that depends on the usage of a ripper instead of a conventional mould board plough. Instead of complete soil inversion as is the case in conventional agriculture with ploughing, farmers make at least 0.15-0.20 meters deep ripped furrows at 0.9 meters spacing in CA while retaining the crop residues and other vegetative matter between ripped lines (CFU, 2009a). This corresponds to tilling 10-12 percent of the land (CFU, 2009b). In both tillage systems of CA, the principle of minimum tillage restricts soil disturbance to precise areas where the crop is to be sown resulting in minimum soil disturbance of around 10 percent of the area (FAO, 2011b).

The Conservation Farming Unit (CFU) of the Zambia National Farmers Union (ZNFU) has championed the training of both institutions and individual farmers in CA in the country through its Conservation Agriculture Programme (CAP), (CFU, 2006; FAO, 2011b). Other non-governmental organizations such as Land Management and Conservation Farming (LMCF) Project, the Golden Valley Agricultural Research Trust (GART), the Institute of Agricultural and Environmental Engineering (IMAG) Project, the Cooperative League of the USA (CLUSA), World Vision and various donors have also been promoting and developing CA in different regions of Zambia since the 1990s.

2.3 Adoption and Diffusion of Innovations

Adoption and diffusion are the processes governing the utilization of innovations such as CA. Studies of adoption behaviour emphasize factors that affect if and when a particular individual will begin using an innovation (Sunding and Zilberman, 1999). Measures of adoption may indicate both the timing and extent of new technology utilization by individuals. Adoption behaviour may be depicted by more than one variable. It may be depicted by a discrete choice, whether or not to utilize an innovation, or by a continuous variable that indicates to what extent a divisible innovation is used (Rogers, 2003).

There are several theoretical perspectives that inform studies on adoption of innovations. Here, the classic and most influential one, the diffusion of innovations theory by Rogers is reviewed. Rogers' innovation-diffusion theoretical perspective identifies information dissemination as a key factor in influencing adoption decision (Rogers, 1962).

2.4 Rogers' theory on Diffusion of Innovations

Rogers' theory or model of diffusion assumes adoption of an innovation is usually received by some people (adopters) that have a higher standing in society. According to Rogers (2003) there are many qualities in different people that cause them to accept or not to accept an innovation. There are also many qualities of innovations that can cause people to readily accept them or to resist them (Rogers, 1962). If an innovation is better than its predecessor, it will eventually be adopted. However, if the innovation goes against the norms and values of the people, they will be less likely to adopt it. Simplicity of use is also a major factor in enhancing the adoption of innovations. No matter how good an innovation can prove to be, people will be hesitant to adopt it if it is difficult to learn and to use. Most important, when people begin to see the good that the innovation is doing for them and for their neighbours, they will find it difficult to resist its adoption.

According to Rogers (1962), information dissemination is a key factor in influencing adoption decision. Other factors that have been identified to influence diffusion rates of innovations include: adopter characteristics, the social network they belong to, the communication process, the characteristics of the promoters, and the innovation attributes including triability, relative advantage, compatibility, observability, and complexity. The point of departure of this study is that this theoretical perspective which identifies information dissemination as a key factor in influencing adoption decision can also be used to study what influences the disadoption decisions of the recipients of new innovations. Information has to be disseminated from one farmer to another on the disadoption of an innovation only that it might not be publicized on media like radio and television. To facilitate implementation and management of CA and its diffusion in Zambia, farmers are divided into groups. Each group is headed and directly administered by a lead farmer (what is called an early adopter according to Rogers (1962). The lead farmer is identified and appointed by the project implementers. For example, the CFU trains and provide agricultural inputs to its lead farmers at the beginning of each agricultural season and the lead farmers, in turn, pass on the knowledge and inputs to the farmers belonging to their group. Being lead farmers and primary implementers of the CFU's programme at the lowest level, these lead farmers are expected to exert some influence on their farmers, rendering them potentially effective technology diffusion agents. This knowledge would not only be mandatory practices learnt from CFU but also any other knowledge that they might have gained and are implementing from other sources.

2.5 Critique of Rodgers

Rogers' analyses miss some important facets in the diffusion of complex technologies. Though his theory is applicable to the study of diffusion of innovations, his model of diffusion only assumes adoption of an innovation which is usually received by some people (adopters) that have a higher standing in society. It does not consider that some people would easily lose interest and disadopt an innovation, or on the other hand that an innovation would first be received by the people that are not influential because the assumption is that innovations only breakthrough in a society by way of meeting key informants first. In some instances there are also reversed processes where the innovation is dropped or its' use retarded. According to Lyytinen and Damsgaard (2000:1),

> "Researchers should carefully recognize the complex, networked, and learning intensive features of technology; understand the role of institutional regimes, focus on process features (including histories) and key players in the diffusion arena, develop multi-layered theories that factor out mappings between different layers and locales, use multiple perspectives including political models, institutional models and theories of team behaviour, and apply varying time scales while crafting accounts of what happened and why."

In the case of CA in Zambia, this would entail researchers asking questions about who are the important players in the smallholder agricultural sector and what are their goals? What are the histories of the presently dominant technologies used by smallholder farmers? How did they come to be dominant and why? What types of theories and models influence the dominant technologies used by smallholder farmers?

Rogers' theory considers innovations or technologies as static. Technologies are not static for there is continual innovation in order to attract new adopters, (Lyytinen and Damsgaard, 2000). In the same vein the communication process involved in the diffusion of innovation approach is a one-way flow of information. In complex environments where the adopter is receiving information from many sources and is returning feedback to the sender, a one-way model is insufficient and multiple communication flows need to be examined (Robertson *et al.*, 1996). The sender of the message has a goal to persuade the receiver, and there is little to no dialogue. The person implementing the change controls the direction and outcome of the campaign. In some cases, this is the best approach, but other cases require a more participatory approach.

Direct or indirect financial payment incentives have been used to support the individuals of a social system in adopting an innovation (Gukurume *et al.,* 2010). Incentives are part of support and motivation factors. There have been some efforts in different countries to increase adoption, such as through the provision of economic incentives and the creation of organizations to provide exclusive support to CA (Joysee, 2005). It is argued by Gukurume *et al.,* (2010) that the Non-Governmental Organizations (NGOs) want their projects to be successful so that they can continue to receive funding from the donors. The Sub-Saharan Africa governments and extension workers, as well as the local authorities, are more inclined towards donor funded projects because a number of benefits also accrue to them for taking a supportive stance towards CA. Nonetheless, the impact of these efforts seems to be very limited. The short duration of most projects mean that it is rarely possible to follow through the innovations introduced, especially those which are knowledge intensive in nature which require sustained efforts in terms of time and resources. As observed by Chiputwa *et al.,* (2011), disadoption rate is relatively higher among zero-tillage farmers compared with other technologies, more especially when a funded project ends.

There are several studies on factors influencing adoption including one on CA adoption in Zambia by Nyanga (2012) who found that good rapport with farmers, trust, reciprocity and altruism, monitoring and evaluations, extension strategy, quality and extent of technical knowledge in CA within CFU, and artificial incentives positively influenced adoption of CA. The other study is on development, diffusion and impact of Conservation Farming in Zambia by Haggblade and Tembo (2003) who reported that incentives for adoption of water-conserving CA technologies prove strongest in Zambia's Agro-ecological Regions I and IIa, regions of erratic rainfall and extensive plow-pan damage. Lastly is the study on adoption and intensity of adoption of Conservation Farming practices in Zambia by Arslan *et al.,* (2013) who explained that extension services and rainfall variability are the strongest determinants of adoption. This suggests that farmers use these practices as an adaptation strategy to mitigate the negative effects of variable rainfall. There is little literature on factors influencing disadoption of CA in Zambia. This study therefore will fill this knowledge gap and explore in depth the factors that cause smallholder farmers to disadopt CA.

CHAPTER THREE: DESCRIPTION OF THE STUDY AREA

3.1 Introduction

This chapter describes the physical and socio-economic characteristics of the study area. It describes the location of Petauke District in Eastern Province of Zambia and the location of the study area in Petauke District. The study was conducted in two agricultural camps of Petauke district Eastern Zambia (Figure 3.1). These are Wankhala and Mwanjawanthu. These were selected for the study as anecdotal evidence existed about disadoption of CA there. Petauke district has 37 agricultural camps. Conservation Agriculture is practiced in 25 of these agricultural camps. The sampling frame was two (2) camps out of these 25 agricultural camps where CA is practiced.

3.2 Location

Petauke district is situated 420 km east of the capital city Lusaka, and 180 km west of Chipata, the provincial headquarters. It is located in the southern part of Eastern Province, (Figure 3.1). The areal extent for Petauke District is 8,359 km², (CSO, 2012).

3.3 Physical Characteristics of the Study Area

3.3.1 Rainfall and Temperature

Petauke receives average annual rainfall of between 800mm to 1000mm, although when droughts are experienced, annual rainfall averages less than 600mm. The length of the growing season ranges from 139 to 155 days. The average daily temperature varies between 18°C to 31°C during the hottest month of October and 6° to 23°C during the coldest month of July (Chomba, 2004). The mean annual temperature is 21°C ranging from 10.6°C in July to 31.5°C in October.

3.3.2 Altitude

Petauke District has an average altitude of 1,030 meters, (Chomba, 2004). It is generally a plateau area which comprises undulating hills at an average altitude of 900 to 1500 meters above sea level. Most of the land is in the middle veld with seasonal rivers that generally flow from December to August (Trapnell, 1953).

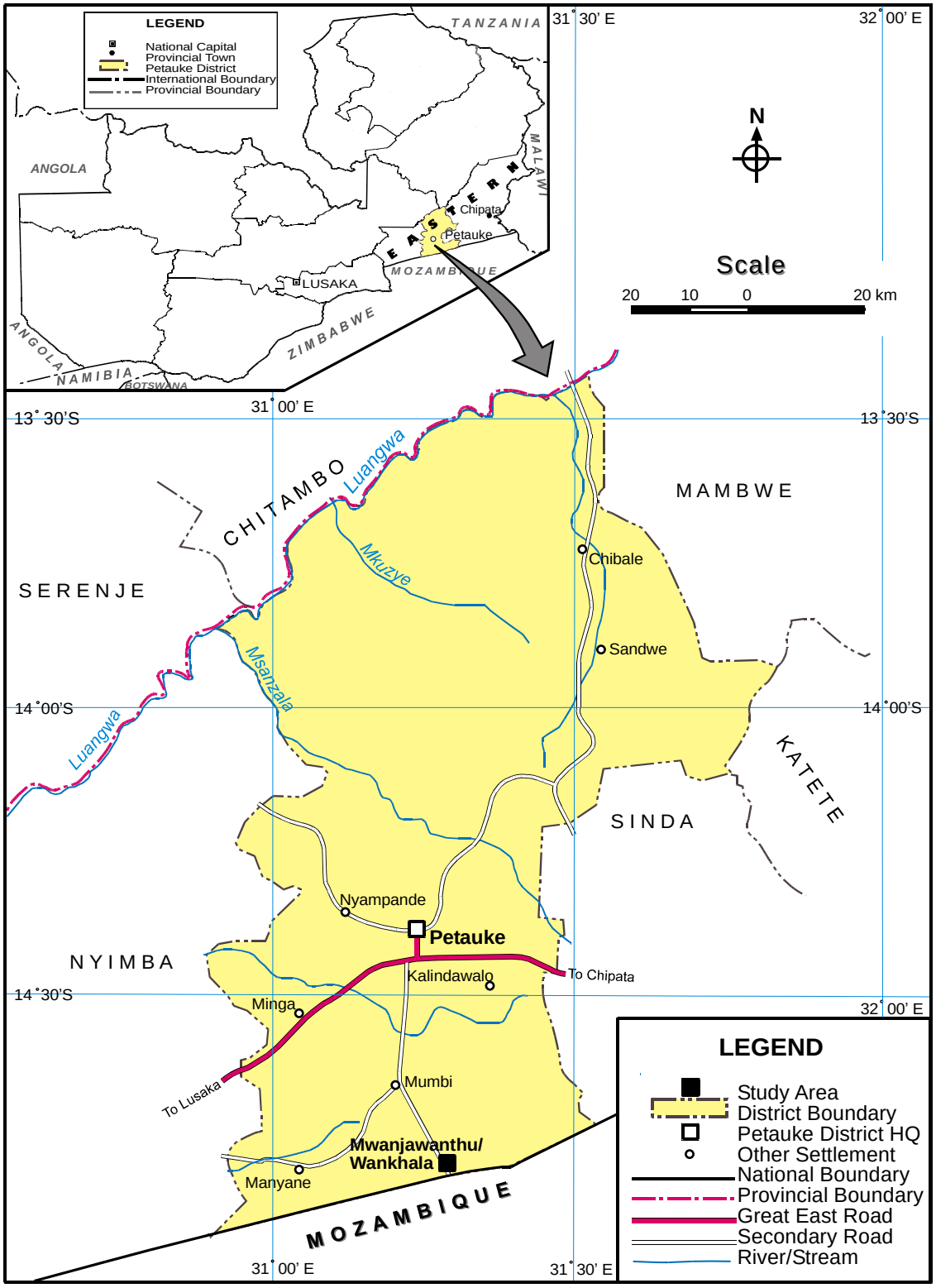

Figure 3.1: *The location of Mwanjawanthu and Wankhala in Petauke District*
Source: UNZA, 2017

3.3.3 Soils

Trapnell (1953) observed that the soils in Petauke are generally brownish to yellowish red. In highlands they range from coarse sandy clay loams to sands. Further down the slope there is however a gradual transition from sandy clay loam soils to much more pallid and sandier, whereas around the dambos soils are usually dark in colour and sticky.

3.3.4 Vegetation

The vegetation type in different parts of the district is largely related to the amount of available water and the soil type. Characteristically, the vegetation includes mixed forests, thickets, woodlands, and grass especially in dambos. *Miombo* woodlands with its characteristic vegetation *Julbernadia globiflora, Brachystergia boemehmii,* and *Sterculia Africana trees*; and *Hyperrhaenia newtonii, Hyperrhaenia rufa, Hyperrhaenia filipendula and Dactyloctenium*, form the dominant vegetation in Petauke and so do grassy dambos (Trapnell, 1953).

3.4 Socio-economic Characteristics

The Central Statistical Office (2012) reported that Petauke is one of the districts that has been experiencing rapid population growth as well as other related socio-economic activities. According to the Central Statistical Office (2012), it has a population of 297,186 people and a population density of 36.8 persons per square kilometre which is higher than the national average of 31.7 persons per square kilometres and that of Eastern Province which is 24.6 persons per square kilometre.

Petauke is generally an agricultural district where farmers practice both arable and pastoral farming. Agricultural production is oriented towards local needs and farmers' products are sold on local markets. Generally farmers practice traditional farming methods using the traditional hand hoe and the plough. The major crops grown are maize (*Zea mays*), groundnuts *(Arachis hypogaea),* sweet potatoes *(ipomoea spp),* beans *(phaseolus vulgaris),* pumpkins *(cucurbitaspp),* cotton (*gossypium spp*) and sun flower *(helianthus spp)*. The common livestock reared are cattle, donkeys and goats. Most of the smallholder farmers in Petauke district live in clustered settlements referred to as villages of up to 100 homesteads (CSO, 2012).

CHAPTER FOUR: RESEARCH METHODS

4.1 Introduction

This chapter describes the methods that were used to collect the data in this study. Also, the methods and instruments that were used to analyze the data obtained are explained.

4.2 Selection of Respondents

The two study sites, Wankhala and Mwanjawanthu have population sizes of 2350 and 1450 respectively. Together, they have 920 households, all of whom are farming households (Ministry of Agriculture and Livestock, 2013). An updated register with 920 smallholder farming households accessed from the Ministry of Agriculture and Livestock district offices was used as a sampling frame. A sample of 92 households which is 10 percent of the smallholder farming households of the study area was obtained using random sampling. This was done by simply counting without numbering the respondents first from the register using an equal interval starting with a randomly selected respondent on the register. Bless and Achola's (1990) rule of thumb suggests that to obtain a good sample in any study one can target 5 percent of the total population.

Purposive sampling was used in the selection of key informants and respondents for focus group discussions (FGD) so as to have participants who are known to have opinions and experiences on the topics for discussion. Key informants included extension officers, village headmen and lead farmers working under the Community Markets for Conservation (COMACO) programme of the Wildlife Conservation Society. Key informants were selected on the basis of their intimate knowledge on CA and the activities of COMACO.

4.3 Data Collection

A Mixed methods approach, involving the use of both quantitative and qualitative research tools was used in the collection of data. Quantitative research is an inquiry into an identified problem, based on testing a theory, measured with numbers, and analyzed using statistical techniques (Mason, 1996). According to Creswell (1994) the goal of quantitative methods is to determine whether the predictive generalizations of a theory hold true. It can be used to generalize research findings when it has been replicated on many different populations and sub-populations. The limitations of quantitative methods are that study might miss out on phenomena occurring because of the focus on theory or hypothesis testing rather than context

and detail (Creswell, 2009). Knowledge produced might be too abstract and general for direct application to specific local situations, contexts, and individuals. Quantitative methods are useful for obtaining data that allow generalizations. By contrast, a study based upon a qualitative process of inquiry has the goal of understanding a social or human problem from multiple perspectives. Qualitative research is conducted in a natural setting and involves a process of building a complex and holistic picture of the phenomenon of interest (Mason, 1996). Qualitative methods are useful for describing complex phenomena. They provide understanding and description of people's personal experiences of phenomena. With the use of qualitative methods, the researcher can describe in rich detail phenomena as they are situated and embedded in local contexts. The researcher almost always identifies contextual and setting factors as they relate to the phenomenon of interest.

The challenge with qualitative method is that the knowledge produced might not generalize to other people or other settings (findings might be unique to the relatively few people included in the research study) and it is difficult to make quantitative predictions. In the same vein the results of qualitative methods are more easily influenced by the researcher's personal biases and idiosyncrasies (Creswell, 1994). The mixed methods approach offers an opportunity to draw from the strengths of both quantitative and qualitative research approaches (Johnson and Onwuegbuzie, 2004). Integrating quantitative and qualitative research methods lends depth and clarity of the problem under study (Kothari, 2004).

In this study, the quantitative data collection method used was questionnaires (see Appendix I) while the qualitative ones were the focus group discussions (see Appendix II), personal interviews, informal discussions and observations. The mixed method approach helped to collect data that aided in having a clear understanding of disadoption of CA. Information which was not coming out clearly using a questionnaire was freely coming out during the FGDs where the respondents could express themselves freely and share ideas with other smallholder farmers. For example, there was clear understanding on how incentives were distributed and shared between smallholder farmers and lead farmers. This is because the respondents could share their experiences freely with other respondents who had similar experiences.

4.3.1 Questionnaire Survey

Quantitative data was collected using a questionnaire (Appendix I) on randomly sampled smallholder farmers and was administered by the researcher and two research assistants. The

questionnaire was in English and was interpreted in the local language *(Nsenga)* by the researcher and research assistants to the respondents who had challenges with English. The questionnaire had both open ended and closed questions.

4.3.2 Focus Group Discussions

Qualitative data was collected through four focus group discussions (FGD) using the interview guide (Appendix II) that is two from each agricultural camp. Each FGD consisted of six to ten discussants with at least four women discussants. The age range of the discussants was between 20 to 60 years old. The discussants comprised of CA farmers, CA disadopters and CA non adopters. The three groups were used in order to have different or varied perspectives on their experiences with CA and what changes they (CA non adopters) have seen among those practicing CA and those who disadopted CA, and have comprehensive understanding on issues to do with CA. As the discussions were in progress the relevant information was recorded on paper by the researcher and the assistants. The issues under discussion were to find out the reasons why smallholder farmers disadopt CA and what they resort to after they disadopt.

4.3.3 Key Informant Interviews

Key informants, totaling seven, were also interviewed using the interview guide (see Appendix III). Key informants included the extension officers (2), village headmen (2) and lead farmers (3) in the study area. The topics discussed were on the challenges smallholder farmers were experiencing with CA, the factors leading to CA disadoption and solutions to the challenges.

4.3.4 Informal Discussions and Observations

Information was also collected through informal discussions with some smallholder farmers and key informants, and through personal observation at their respective farms. The tillage methods, area under tillage or sizes of the fields, weeding methods, and labour allocations were observed.

4.3.5 Desk Analysis

Literature such as agricultural extension manuals and annual reports, monitoring and evaluation reports on CA promoting organizations, were reviewed on such issues as numbers of CA adopters and disadopters.

4.4 Data Analysis

Qualitative data analysis was a continuous process and started during the data collection phase on identified major themes and ended with an in-depth description of the results, (Johnson and Onwuegbuzie, 2004). Exploratory thematic and content analysis (Johnson and Onwuegbuzie, 2004) were used for this study. Descriptive (percentages) and inferential (chi-square and binary regression) statistics were used to summarize quantitative data using SPSS, Minitab and Excel. Associations between CA disadopters and non CA disadopters in explanatory variables were tested using chi-square test. The level of significance for decision making was 0.05.

A binary logistic regression was used in CA disadoption model to determine factors influencing disadoption of CA among smallholder farmers. According to the diffusion of innovation theoretical perspective a farmer's response towards an innovation is binary, either adopts or rejects, in this case it is either the farmer's response is continue practicing or disadopt. This is an extension of Roger's theory which only looks at adoption or rejection of an innovation. Hence the model for CA disadoption was specified as

$$\text{Logit } (P(y=1)) = \log (P/(1-P)) = \alpha + \beta 1X1 + \beta 2X2 + \beta KXK \quad (1)$$

where Y is a categorical (dependent variable) response variable with 1=disadopters and 0=otherwise; α is the intercept; $\beta 1$, $\beta 2$. βk are coefficients of independent (explanatory, predictor, input variables) variables X1 X2. XK; P is the probability of disadopting CA and (1-P) is the probability that a farmer does not disadopt CA.

Since a smallholder farmer either did not have an area of land under CA (disadopter) or still had an area under CA (non disadopter) it was most appropriate to use a binary logistic regression model (Freedman, 2009). A smallholder farmer is said to be a disadopter, if she or he stops using CA. The model is based on the assumption that disadoption is likely to be influenced by many of the same factors that influence adoption. The model was tested using Minitab. The goodness-of-fit tests all have very high p-values and the results suggest that the model fits.

The results from qualitative and quantitative methods were combined for the purposes of providing a comprehensive analysis and evaluation by ensuring that the limitations of one type of data are balanced by the strengths of another (Carvalho and White, 1997).

CHAPTER FIVE: RESULTS AND DISCUSSION

5.1 Introduction

The section below presents the sample profile, sources of CA information, the status of CA and the disadoption rates. It further, explains the reasons by the smallholder farmers for disadopting CA. The reasons are given in two contexts; reasons given by the smallholder farmers and also the regression analysis to determine which factors are influencing the disadoption.

5.2 Profile of Respondents

In this study, Mwanjawanthu agricultural camp has more respondents compared to Wankhala agricultural camp Table 5.1. This decision was arrived at because the villages in Wankhala were not easily accessible as compared to those in Mwanjawanthu agricultural camp because it was during the rainy season. The rain season was chosen because the researcher wanted to capture the recent memories of the farmers' experiences during their cultivation programmes. The two agricultural camps were selected to make a comparison on how widespread disadoption of CA was among smallholder farmers from different agricultural camps. The other reason for selecting two agricultural camps was to compare the factors that lead to disadoption of CA among smallholder farmers.

From the 92 respondents 71.7 percent were men and 28.3 percent were women. The age limits of the respondents ranged from 15 to 60 years of age, with an average age of 37.5 years. The least household size of the respondents had two family members and the largest having 13 family members with an average household size of six family members.

Table 5.1: *Respondents by Agricultural Camp*

AGRICULTURAL CAMP	No OF HOUSEHOLD RESPONDENTS PER AGRICULTURAL CAMP	PERCENTAGE PER AGRICULTURAL CAMP
Mwanjawanthu	63	68.5
Wankhala	29	31.5
Totals	92	100.0

Source: Field data, 2016

Results show that 35.9 percent have never been to school and only 5 percent have gone up to senior secondary school. None of the respondents have managed to reach tertiary education (Figure 5.1). Table 5.2 shows the education levels of the respondents in relation to their status

with CA, that is practicing CA, CA disadopters and never adopted CA. Education is an important aspect in the diffusion of innovations. Education increases the ability of farmers to obtain, process, and use information relevant to the technology, leading to greater use and sustainability of new technologies (Wozniak, 1984). The adopters need to understand and have updated knowledge on the innovation promoted to them.

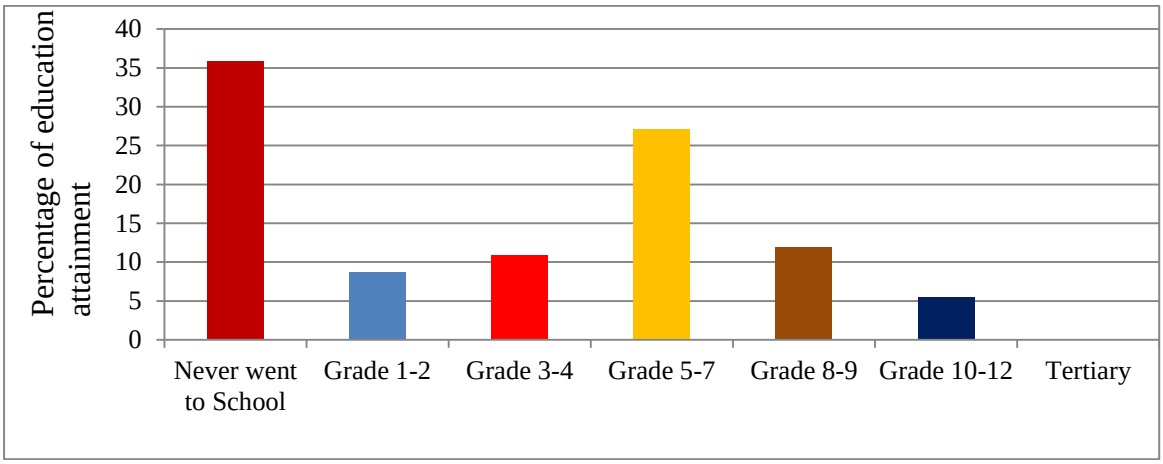

Figure 5.1: *Education levels among smallholder farmers*
Source: Field data, 2016

Wozniak, (1984) noted that literate household heads are more likely to make informed decisions and apply new technologies more effectively. Haggblade and Tembo (2003), note that the level of education and experience influences the ability of farmers to manage the technology. More experience may allow learning by doing, which can make a new technology more profitable (Pedzisa *et al.*, 2015).

Table 5.2: *CA adoption and education level in the study area*

EDUCATION LEVELS	ALL RESPONDENTS PERCENTAGE	PRACTICING CA PERCENTAGE	CA DISADOPTER PERCENTAGE	NEVER ADOPTED CA PERCENTAGE
Has never attended school	35.9	40	25.9	40
Grade 1-2	8.7	10	3.7	11.1
Grade 3-4	10.9	10	11.1	11.1
Grade 5-7	27.2	25	37.0	22.2
Grade 8-9	12.0	5	14.8	13.3
Grade 10-12	5.4	10	7.4	2.2

Source: Field data, 2016

5.3 Sources of Information on CA

The information on CA has been disseminated to different areas from farmer to farmer and using different media such as the radio and television. All of the 92 respondents were aware of CA. Their sources of information on CA were from radio and television, CFU and from their fellow farmers. Of the three sources 42.4 percent of the respondents got the information from fellow farmers, 38 percent from CFU and 19.6 percent from radio and television. These results showed that the most dominant means of innovation dissemination was farmer to farmer. Similarly, CA disadoption messages and experiences could be spreading mainly through farmer to farmer. This is the case because issues such as disadoption of innovations are rarely publicized in the media like radio and television.

5.4 Status of CA Practice and Disadoption

From the randomly selected respondents, results showed that 29.3 percent smallholder farmers disadopted CA, 21.8 percent were still practicing CA and 48.9 percent never adopted CA. The CA tillage methods that were researched on were; CA basins, ripping and tractor ripping. Results show that of all the common CA tillage systems used among smallholder farmers in the two agricultural camps, CA basins were the most disadopted with 96.3 percent and ripping was the least disadopted with 3.7 percent. There was no smallholder farmer using the tractor ripping technology and owning tractor ripping implements in these two agricultural camps.

The results further showed that 96.7 percent of the respondents found ripping technology to be the simplest to handle and they had less challenges with it, however only 3.3 percent were using the ripping method due to difficulties in accessing the rippers. According to Rogers (2003), simplicity of use is also a major factor in the adoption of innovations. No matter how good an innovation can prove to be, people will either be hesitant to adopt or will disadopt it if it is difficult to use and to learn. Most important, though, are observable results. When people begin to see the negative effects that the innovation is doing for them and for their neighbours, they will find it difficult to resist the temptation to disadopt it.

Disadoption of CA has been an ongoing process amongst the smallholder farmers over four farming seasons (Table 5.3). For the four farming seasons at the time of research, 2011/2012 farming season had the highest CA disadoption rate of 44.4 percent and the farming season with the least disadoption rate was the 2012/2013 farming season with 14.8 percent.

Disadoption was high during the 2011/2012 farming season because it was an election year and farmers were not sure of what policies would come with the new government.

Table 5.3: *CA disadoption across four farming seasons*

FARMING SEASONS	FREQUENCY	PERCENT
2009/2010 farming season	5	18.6
2010/2011 farming season	6	22.2
2011/2012 farming season	12	44.4
2012/2013 farming season	4	14.8
Total	27	100

Source: Field data, 2016

5.5 Factors that lead to Disadoption of CA

This section explains the factors or reasons that lead to disadoption of CA. These reasons are in two contexts; the reasons given by the smallholder farmers for disadoption and the regression analysis in determining the reasons influencing disadoption. For disadoption of any technology to take place there should be demotivating factors that would influence such behaviour towards an innovation among the recipients. Results showed that the most common factors cited for disadoption are lack of transport, high labour demands and lack of incentives. The least identified reason for disadopting was lack of CA equipment as shown in Figure 5.2.

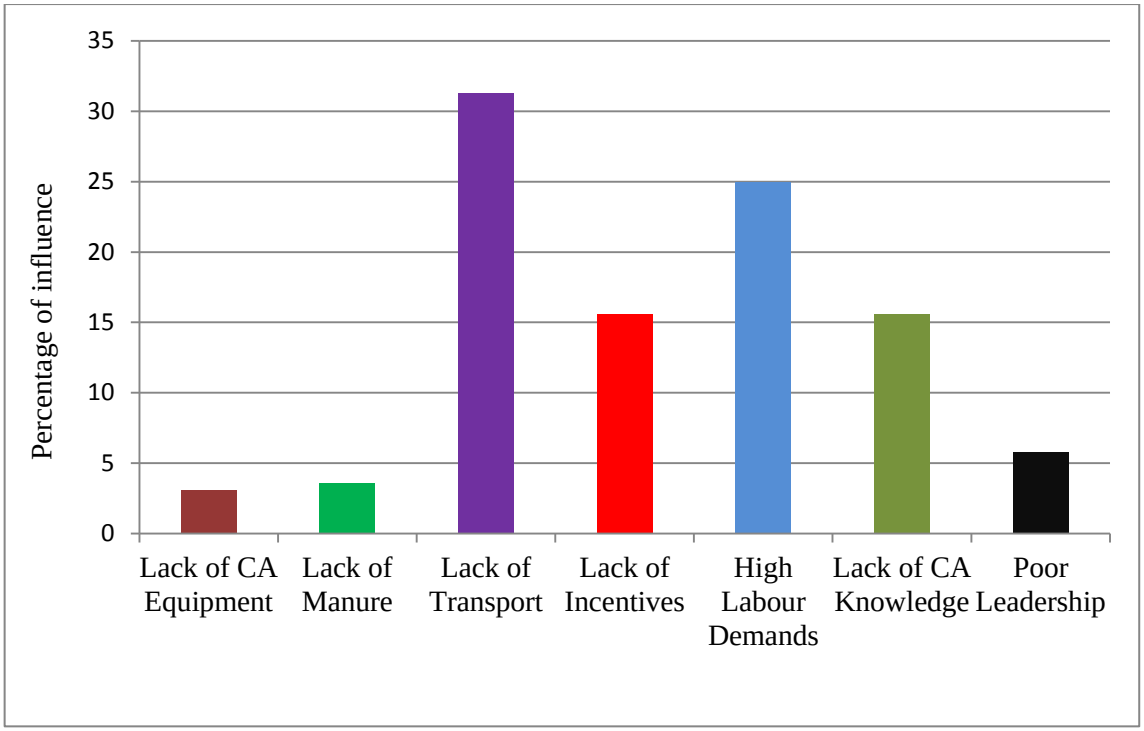

Figure 5.2: *Factors leading to CA disadoption*
Source: Field data, 2016

A chi-square was also used to test if there was any significant association of these reasons given by the smallholder farmers with disadoption. The results from chi-square test showed that lack of access to transport for manure, CA labour demand, lack of access to CA incentives and poor local CA leadership were significantly associated with disadoption. In the same vein access to relief food, ownership of CA tillage assets (cattle) and equipment (*chaka* hoe), gender, location, education levels attained and CA trainings attended were not significantly associated with disadoption at 95 percent significant level (Table 5.4).

Table 5.4: *Descriptive statistics for explanatory variables used in the regression model*

Variables	Variable description	CA Disadopters (n=27) (%)	Non CA Disadopters (n=65) (%)	Chi-square
Location	Wankhala agricultur camp	44.4	26.2	
	Mwanjawanthu Agricultural Camp	55.6	73.8	
	TOTAL	100	100	2.957
Gender	Men	77.8	69.2	
	Women	22.2	30.8	
	TOTAL	100	100	0.687
CA Labour attribute	Labour intensive	81.5	52.3	
	Non-labour intensive	18.5	47.7	
	TOTAL	100	100	6.816*
Education levels attaine	No education	25.9	38.5	
	Primary	51.9	46.2	
	Secondary	22.2	15.3	
	TOTAL	100	100	1.504
Food security (Relief food distribution)	Received	29.6	29.2	
	Did not receive	70.4	70.8	
	TOTAL	100	100	0.001
Assets owned	**Chaka hoe**			
	Yes	11.1	16.9	
	No	88.9	83.1	
	TOTAL	100	100	0.499
	Cattle			
	Yes	55.6	46.2	
	No	44.4	53.8	
	TOTAL	100	100	0.675
Access to CA Incentives	Yes	29.6	75.4	
	No	70.4	24.6	
	TOTAL	100	100	16.943*
CA trainings attended	Attended	48.2	67.7	
	Never attended	51.8	32.3	
	TOTAL	100	100	3.091
Transportation of manure	Had challenges	96.3	67.7	
	No challenges	3.7	32.3	
	TOTAL	100	100	8.578*
Local CA Leadership	Good	66.7	93.8	
	Poor and Bias	33.3	6.2	
	TOTAL	100	100	11.614*

***** Significant at 0.05 level

Source: Field data, 2016

The chi-square test does not show the effect of explanatory variables on the response variable. This effect is shown in regression analysis Table 5.5.

Table 5.5: *Regression estimates for socio-economic factors explaining disadoption of CA*

Predictor	Coef	SE Coef	Z	P
CA Training Attendance				
1=Yes	-2.34037	0.950978	-2.46	0.014
Own means of transport for manure				
1=Yes	-5.06272	1.57150	-3.22	0.001
Location				
Wankhala	2.23189	0.853520	2.61	0.009
Gender				
Women	-0.515090	0.925073	-0.56	0.578
Cattle Ownership				
Yes	0.840135	0.741815	1.13	0.257
Local CA Leadership				
1=Good	-1.00747	1.00972	-1.00	0.318
Access to Incentives				
1=Yes	-2.34338	0.826246	-2.84	0.005
CA Labour Attribute				
1=Labour intensive	0.535613	0.818145	0.65	0.513

Log-Likelihood = -29.414
Test that all slopes are zero: G = 52.535, DF = 8, P-Value = 0.000

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	25.0028	42	0.983
Deviance	28.3662	42	0.947
Hosmer-Lemeshow	8.6531	8	0.372

Source: Field data, 2016

5.5.1 Transportation of Manure

A regression model for CA disadoption showed that there is a significant likelihood of increased disadoption of CA by smallholder farmers who do not own means of transport for manure (p-value of 0.001) (Table 5.5). This implies that smallholder farmers that do not have transportation means for manure are more likely to disadopt than those that have. Results show that 49 percent own cattle with an average of five cattle per household.

Transport is a very important aspect in the life of a smallholder farmer for it helps ease the burden of carrying heavy implements and other materials to be used on the farm. It helps the smallholder farmer to get linked with other farmers and places. An oxcart is a common means of transport used in the two agricultural camps. This entails that ownership of cattle is cardinal to the smallholder farmers. Manure (cow dung) is commonly used by the smallholder farmers in these agricultural camps to improve soil fertility. This is because in each village there are some farmers who own cattle which is a source of manure. Generally it was observed that most of the smallholder farmers do not own ox-carts which they can easily use to carry manure. Results further indicate that lack of access to oxen and transport to carry manure and difficulties to find manure influenced the smallholder farmers to disadopt CA. Of the respondents from Mwanjawanthu agricultural camp and respondents from Wankhala agricultural camp who disadopted CA, 69 percent and 18 percent respectively cited manure transportation as a challenge. The fact that manure is mixed with the soil and becomes very heavy to carry coupled with the distance covered to transport it manually discouraged smallholder farmers without transport as explained by the discussants in a focus group discussion. Another focus group discussant further explained that the smallholder farmers do not have their own transport as a result they use human porterage (carrying manure packed in the 50kg sacks on the head). Women and children suffer the most in the transportation of manure on the head because they are the most involved in cases of manual transportation. Others, especially men use bicycles to carry manure but in small quantities which takes time for one to cover a field of one hectare for example. This has made some smallholder farmers to only have small fields or lines under CA or completely disadopt it. This is supported by Marongwe *et al.,* (2011) who reported that even though promotion increased the number of farmers practicing CA, expansion in the CA area has been more modest. Ndlovu *et al.,* (2013) and Mazvimavi *et al.,* (2008) assert that CA is practiced on smaller plots compared to conventionally tilled plots. Moreover, most farmers have only adopted a subset of CA and more and more farmers are choosing to disadopt their use (Giller *et al.,* 2009; Gowing and Palmer, 2008).

5.5.2 Labour Demands and Asset Ownership

A regression model for CA disadoption showed that there is high likelihood of disadoption for smallholder farming households that perceived CA to be labour intensive (p-value of 0.513) (Table 5.5). Results show that 25 percent reported that CA basins were labourious and too

cumbersome to make. *"The CA basins demand alot of labour for them to be done and almost everyone in the family needs to be involved for you to be fast,"* argued a discussant in a FGD. The labour constraint in CA manifests itself during land preparation and weeding. Other discussants complained that it was expensive to hire labour to dig the basins as compared to conventional tillage. In addition, 10 percent reported that labour demand increases when the family size is small. Larger families are less labour constrained and are likely to persist with digging basins because they have readily accessible labour resources compared to small sized families explained the FGD discussants. The common trend in these two agricultural camps is that even among those still practicing CA, they have their biggest fields under conventional agriculture and small fields or only partial field under CA.

The practice of basins is also challenging because most of the people who are practicing it are women than men as indicated in the focus group discussions and by a key informant. This is because hand hoeing was mostly in the domains of women than men. Most of the work on the farm is done by women such that with an addition of the labour demand from the digging of the basins, women are found to have less time to rest. Women do not have the capacity to hire labour as a result they end up disadopting CA. *"We are now happy after disadopting CA because we have enough time to rest as compared to when we were still practicing CA especially the basins,"* said one of the smallholder farmers who disadopted CA.

Farm assets are important for easing the farm duties. The common farm assets that are used in CA are ridger, *chaka* hoe, ripper, tractor and tractor ripper. Results showed that 85 percent did not own a *chaka* hoe and 96 percent did not own a ripper. The tractor is the scarcest farm asset in the area of study and none owned a tractor or a tractor ripper. Generally smallholder farmers disadopted CA (ripping) due to the financial challenges to buy the rippers for they were more expensive and rarer to find than the plough. Discussants explained that they tried to buy rippers as groups but failed due to lack of commitment from the group members remaining with the option of just disadopting CA (ripping) and falling back to conventional methods. They further indicated that rippers can be of great help for them to continue with CA because they had oxen already for draught power.

For those respondents who disadopted CA, 41 percent suggested that to reduce on labour demands to dig the basins, the smallholder farmers should shift from using the *chaka* hoe to using the ripper. A *chaka* hoe has an elongated thick strong blade and a long handle as compared to a traditional hand hoe. These features of a *chaka* hoe account for its heaviness

relative to a traditional one. "*The heaviness of the chaka hoe makes it hard to be used especially during the dry season when the soils are hard*," a respondent reported. The end result is disadoption of the basins. As elaborated by Nyanga *et al.,* (2012) the increase in labour requirement is due to the high accuracy and precision demanded in CA basin digging that involves the use of teren ropes, a pair of 0.9 meter sticks and a pair of wooden pegs in addition to following recommended measurements for the size of basins. Nyanga *et al.,* (2012) further noted that the way of using the *chaka* hoe in tillage made it exhausting because it had to be swung from beyond the shoulders at a reasonable speed so that the weight of the hoe can break the soil easily. To the farmers, the costs of engaging in CA basin making far outweighs the perceived benefits of this aforesaid tillage technique, which other farmers have called, "Diga ufe" (euphemistically meaning dig and die), leading to negative repercussions on the success of CA promotion programme, (Gukurume *et al.,* 2010). Gukurume *et al.,* (2010:46), further say that "traditionally, this farming method was preserved for those in the impecunious category who neither had draught power nor the money to hire people to till the land on their behalf."

Although smallholder farmers disadopt conservation agriculture because of the aforementioned reasons, their disadoption is enhanced by traditional perceptions of digging the basins. A regression model though not significant showed that there is a likelihood of CA disadoption by smallholder farmers who owned cattle Table 5.5 (p-value of 0.257). Further results show that 56 percent of smallholder farmers who disadopted CA have herds of cattle for draught power giving them an option away from the intensive labour demand of digging basins. One respondent explained *"what will be the use of cattle, then, if I dig basins myself instead of using the cattle for draught power."* Generally the smallholder farmers agreed that ripping was more labour saving than ploughing. A discussant reported that *"I am ready to re-adopt CA if a ripper is given to my family for it can reduce my time and labour in the field than digging the basins and ploughing."* Using the ripper helps the pairs of oxen used in tilling the land to have enough time for resting as compared to ploughing. This is consistent with the results by Umar *et al.,* (2012) that it took 3.8 man hours/ha to plough but only 0.8 man hours/ha to rip. However, this study has shown that access to the rippers was a challenge hence forcing the smallholder farmers to disadopt CA and go back to ploughing.

A number of authors argue that labour demand is the major constraint to CA adoption in Zambia (Umar *et al.,* 2011; Baudron *et al.,* 2007; Haggblade and Tembo, 2003). Nowak

(1991) notes that increase on labour requirement is one reason that farmers do not continue with conservation agriculture. Pedzisa *et al.*, (2015:76) add that "a larger household size implies greater access to labour, leading to a higher probability of continuing with CA compared to households with smaller families." This study has also shown that increase in labour demand increases the likelihood of disadoption of CA significantly.

5.5.3 Lack of Adequate Knowledge in CA

The lack of adequate knowledge in CA was cited by 15.6 percent of the respondents as a contributing factor to disadoption of CA. The CA disadoption regression model shows that attendance of training in CA significantly reduces the likelihood of CA disadoption, p-value of 0.014 (Table 5.5). This implies that as farmers attend CA trainings the likelihood of disadoption reduces. Results show that there were four main trainings that were conducted by CFU in a year. The distribution of attendance show that the most attended training was the digging of CA basins and the least attended was application of herbicides Figure 5.3.

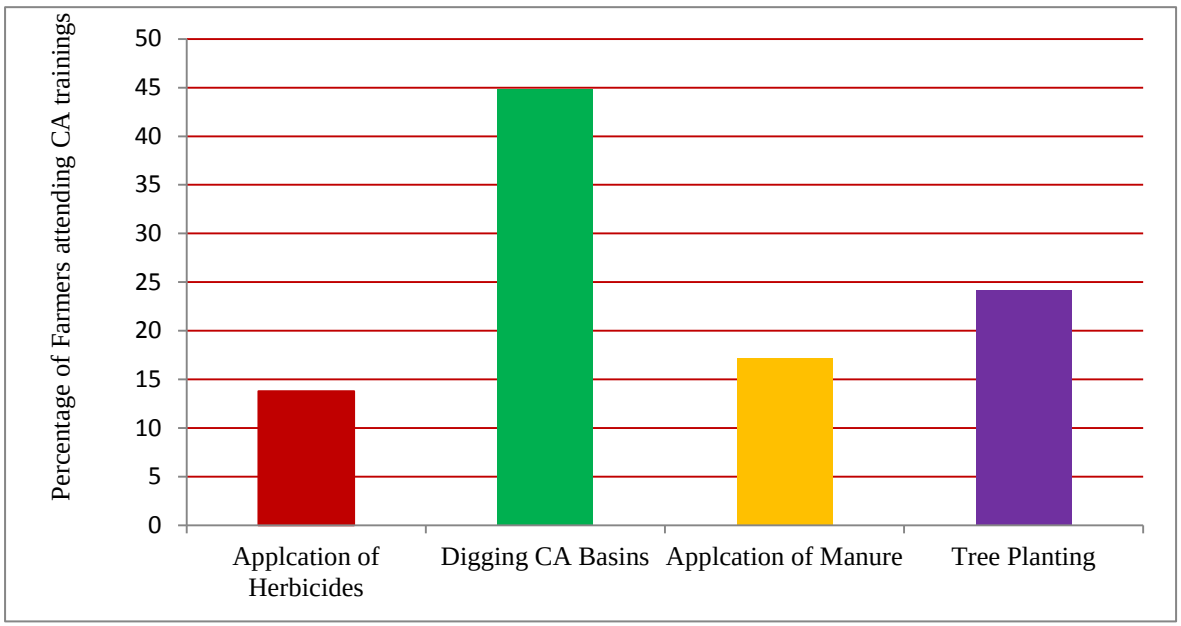

Figure 5.3: *Types of CFU trainings*
Source: Field data, 2016

Despite these four trainings offered only 37 percent attended the trainings which attributes to a lack of knowledge in CA. The farmers in one of the FGDs explained that they could not attend the trainings because of poor local CA leadership which was not inclusive and were not invited to attend. Furthermore the lack of adequate knowledge in CA is also attributed to the

broader extension visits to individual households which were very low Table 5.6. Results show that 73.9 percent were not visited by extension officers for a period of 12 months at the time of the research. These reasons could explain why there is poor or inadequate knowledge in CA. This poor attitude towards trainings on CA and visitations by smallholder farmers and extension officers respectively makes it a fertile ground for a smallholder farmer to easily disadopt CA.

Table 5.6: *Number of times farmers were visited by the extension officers*

VISITATIONS BY EXTENSION OFFICERS IN 12 MONTHS	**FREQUENCY**	**PERCENT**
None	68	73.9
1-3	21	22.8
4-6	2	2.2
7 and above	1	1.1
Total	92	100.0

Source: Field data, 2016

CA trainings were the most important primary source of information on CA tillage systems as indicated by the respondents who attended these trainings. Training increases the ability of farmers to obtain, process, and use information relevant to the technology, leading to greater use and sustainability of new technologies (Wozniak, 1984). The farmer who rarely or does not attend such trainings will lag behind on the latest information on CA that might be available which might lead the farmer to disadopt CA. These results agree with the findings of Nyanga (2012) who found that training in CA significantly increased the likelihood of adoption of CA. These results are also consisted with the innovation diffusion theory (Rogers, 2003) that identified that information access is central in the process of innovation adoption and continued practicing of the innovation. According to Pedzisa *et al.,* (2015) the influence of positive experience among farmers tends to increase their likelihood to persist to use a particular technology. This study is consistent with Pedzisa *et al.,* (2015) for it shows that most of the farmers are disadopting because they do not have adequate positive experience or knowledge in CA.

5.5.4 Weed Control

Weed control and management was reported by all the respondents to be more challenging under CA as weed pressure increased with minimum and/or zero tillage. FGD discussants explained that there is high weed pressure in the fields where they practice minimum tillage. This is because as per CA requirement, fields under CA are not supposed to be ploughed and yet ploughing is a form of weed control. Furthermore the burning of crop residues which is a form of weed control is also discouraged; as a result there is weed pressure as compared to conventional methods.

Manure application is encouraged under CA as a way of adding nutrients to the soil. However, 3.3 percent of the respondents noted that manure supports the fast growth of weed. Cow dung manure contains a variety of seeds which germinate and become weed when the dung is applied in the field. Weeds grow faster than the crop which later affects the growth of the crop and requires two or more cycles of weeding to rid the weed from the fields.

Weed problem is high also due to the inability to buy herbicides to control weed. Generally the smallholder farmers complained that the herbicides were an expensive method of weeding for they have alot of fields but less money to afford buying herbicides which are needed for all the fields. At the time of research a 1 litre bottle of herbicide (Atrazine) was costing US$8.33. One of the discussants said, "*the only option is to deal with the weed using 'katakwala,' the traditional hand-hoe weeding method although it is too labourious especially to our women folk."* Herbicide weed control method was the least used among smallholder farmers accounting for 3 percent (Table 5.7).

Table 5.7: *Weeding methods used by the smallholder farmers*

WEEDING METHODS	**ALL RESPONDENTS**	
	Frequency	**Percent**
Traditional hand hoe weeding	71	77
Oxen weeding	18	20
Herbicides	3	3
Total	92	100

Source: Field data, 2016

A key informant explained that '*smallholder farmers would rather spend once on seed and fertiliser but not on weed control and management, as a result they end up using the methods which reduce the costs and where weed control and management is easy such as ploughing.'* Other researchers such as Umar *et al.,* (2011), observed that the use of herbicides prevent the farmers from practicing mixed cropping as it is difficult to combine use of herbicides with cultivation of legume crops like cowpeas. It is the attached costs to farming that lead the smallholder farmers to disadopt farming technologies like CA which require herbicides to control weeds in their fields.

The traditional hand hoe weeding method was preferred by 77 percent smallholder farmers because it is more effective in weed control compared to the other methods Table 5.7. Further, another respondent explained that the oxen method is fast, less laborious and easier to use but has the challenge of not removing alot of weeds and lack of oxen to do it. On average smallholder farmers take about three weeks to complete weeding their fields when using ADP and about two months or more when using the hand hoe method.

These findings are similar to the findings of other studies that have acknowledged the increased weed pressure with minimum tillage in CA. Arslan *et al.*, (2013) found that one of the oft-mentioned constraints with CA and successful realization of yield benefits from CA is that weed pressure increases during the early years of transition (due to reduced tillage and cover crops), which is especially problematic when households do not have access to herbicides. The CA concept of minimally tilling the soil commonly results in increased weed pressure (Vogel, 1994; 1995). Weeding requirements tend to be higher on CA plots (in the absence of herbicide use) creating another labour constraint (Umar *et al.*, 2011; Arslan *et al.*, 2013). Giller *et al.,* (2009) also observed that the weed problem and limited access to herbicides is quite wide spread in SSA.

5.5.5 Access to Incentives

The CA disadoption regression model indicated that access to incentives significantly reduces the likelihood of smallholder farmers to disadopt CA, p-value of 0.005 (Table 5.5). This implies that the smallholder farmers who lack access to incentives are more likely to disadopt CA. Approximately 21 percent of the respondents reportedly disadopted CA practices because they were not given the promised certified maize seed, fertiliser and other incentives. A discussant complained that *"my friends (lead farmers) are enjoying the incentives but as for*

me, I have been suffering without receiving any incentive as a result I decided to disadopt CA." The discussant further explained that *"they give incentives because they also want funding from their funders, but sometimes these incentives do not trickle down to us, as a result smallholder farmers also end up disadopting their practices so that they have nothing to report to their funders and in turn no funding for them also."*

The provision of incentives to CA farmers has characterized CA promotion in Zambia. A respondent explained that those practicing CA were given different types of incentives from different organizations and CA promoters, and those not given the incentives tend to disadopt CA. The incentives are given out as a way of encouraging the smallholder farmers to continue practicing CA so that the CA promoters can obtain the required results they need to report to their funders. However, the sustainability of such incentivized adoption is questionable, as observed by disadoption of CA once project support is ceased. The incentives received varied from food stuffs, farming implements and cash. The following are some of the incentives; sprayers, *chaka* hoes, rippers, axes, ploughs, ridgers, chains, money in terms of allowances given during meetings to lead farmers, fertiliser, herbicides, seed, bicycles, T-shirts, *chitenge* materials, caps, cooking oil and other food stuffs.

In the quest to qualify to get CA based incentives, some smallholder farmers have small plots under CA and large or big fields under conventional farming methods. This observation was similar to that of Umar *et al.*, (2011) who found that almost all farmers (out of 129 interviewed) practice both conventional and conservation agriculture on different plots. In addition Gukurume *et al.,* (2010) found that the majority of the farmers thrive on misleading the NGOs into believing that they are full members of the project in order to get the much needed seed and fertilizers. Once farmers get such inputs from the 'missionaries' they revert to the conventional farming methods, (Gukurume *et al.,* 2010; Baudron *et al.,* 2007). CA projects have fostered and entrenched a dependency syndrome through reliance on subsidized inputs, (Nhodo *et al.,* 2011). Discussions with farmers revealed that some asked what they would get in return if they adopted CA, (Nyanga *et al.,* 2011). Benefits obtained while practicing a new technology is a motivating factor to smallholder farmers for them to continue with the technology, as noted by Aune *et al.*, (2012).

5.5.6 Local CA Leadership and Location

The regression model though not significant showed that there is a reduced likelihood of smallholder farmers who perceived local CA leadership as good to disadopt CA, p-value of 0.318 (Table 5.5). From the FGDs held, the discussants had mixed feelings on the role the lead farmers played. Discussants further cited poor local CA leadership as another contributing factor for smallholder farmers to disadopt CA. One discussant reported that "*the behaviour of the lead farmers led me to disadopt CA because they are selfish and did not invite me and my friends for CA trainings the reason being they did not want to share the shareable incentives they receive from the donors with others.*" Another one lamented, "*the lead farmers go to town and give fake reports that every farmer benefited from the shareable incentives meanwhile we do not receive the incentives*." These lamentations are in agreement with the regression model that showed that there is a significant increased likelihood of smallholder farmers in Wankhala agricultural camp to disadopt CA, p-value of 0.009 (Table 5.5). Generally it was observed that the incentives attached to practicing CA have brought conflicts between the lead farmers and smallholder farmers leading others to disadopt CA. This could imply that there was poor rapport between the local CA leadership and smallholder farmers in this agricultural camp compared to the other.

Effective communication and good rapport between the leaders (local leadership and extension officers) and smallholder farmers are important in the reduction of disadoption. Extension provides farmers with the information on availability and properties of the new technology and technical skills for using it (Wozniak, 1984). Vanclay (2011) points out that good rapport and providing farmers with practical, useful answers that assist them in their day-to-day operations is important in enhancing adoption and continuity of new innovations. This study has shown that lack of good rapport results in CA disadoption.

5.6 Options for minimizing CA disadoption

This section explains the options for minimizing CA disadoption among smallholder farmers. The options were suggested by the smallholder farmers. Results showed that the most common options cited to minimize disadoption are access to CA incentives, enhanced CA training and access to transport for manure. The least suggested option for minimizing disadopting was herbicide usage (Figure 5.4).

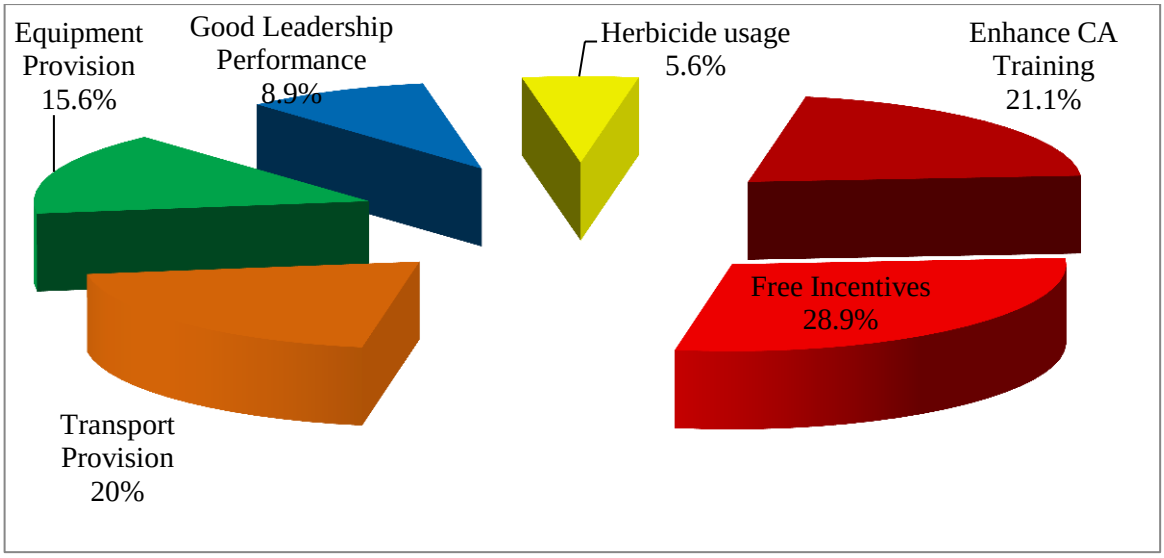

Figure 5.4: *Options for minimizing CA disadoption*
Source: Field data, 2016

These are some of the options that the smallholder farmers identified as a solution to reduce CA disadoption.

5.6.1 Provision of Transport for Manure

From the FGDs, discussants suggested that transport provision and improvement can help ease the burden of carrying manure on the head or shoulders faced in practicing CA. One of the discussants said that, *"(transport provision) to own or be given bicycles, wheel barrows, animals (cattle or donkeys) and an ox-cart from the government or CA promoters can be a great help and solve the transport challenge faced among smallholder farmers."* Further, results showed that 20 percent suggested the need of transport provision from the government and CA funders. The suggestion by smallholder farmers on transport provision does not help them to be self-reliant. There is need for the farmers to reach a point where they can be self-reliant and reduce dependence on the promoters. They should work hard to own their own means of transport which can be helpful to reduce the transport challenges.

5.6.2 Options for CA Labour Intensity Attribute and Asset Ownership

The respondents (15.6 percent) suggested that government and CA promoters should come in and help provide the needed farming equipment and implements like the *chaka* hoe, ripper and tractors to the smallholder farmers so as to help and reduce the labour demand (Figure 5.4). Access to CA equipment is a constraint related to further expansion of conservation

agriculture. Very few farmers have access to a ripper and there is a need for closer engagement with the private sector to improve access to this equipment (Nyanga *et al.*, 2011). Tractors are handy equipment which smallholder farmers in one of the FGDs explained would greatly help them improve their crop productivity and reduce on the burden of labour if given to them by the CA promoters or government either freely or on credit as a group loan to cooperatives. Banks have been giving such loans to cooperatives with collateral. The tractor with a ripper can do a lot of wonders to the smallholder farmers as long as a proper programme is made on how to rotate the tractor for use among them. Such projects can reduce the cost of production, and therefore increase profitability of farming. It can release family labour from field activities to other more rewarding and income-generating activities. Smallholder farmers would find farming more interesting just like those doing white colour jobs so that they can produce more and forget about the heavy burdens they face when doing farming without the help of machines.

5.6.3 Enhancing CA Knowledge

Enhancing CA training was suggested by 21.1 percent of the respondents as a way to help smallholder farmers to access knowledge from the trainers. FGD discussants suggested the need of intensified type of training or enhanced CA training to smallholder farmers. One discussant further said "*I am just practicing CA without any training*." Discussants further reported that the CA trainings by CFU staff were not supposed to end with the lead farmers who later train the farmers but CFU staff should reach the farmers directly. Hence the complaint by 3.3 percent of the respondents that there is need to remove the lead farmers from the CA equation because they were perceived to be selfish and only trained those close to them. A discussant in one FGD said *"if you have a divergent view from that of the lead farmers just know that you are cut off or black-listed from anything to do with CA as long as they are there."* Another FGD discussant said;

> The CFU officials, extension officers and CA promoters should reach all the farmers so that we can share with them our experiences with CA instead of the lead farmers only who sometimes mislead the CFU officials, extension officers and CA promoters.

It is through these interactions between CFU officials, extension officers, CA promoters and farmers that 42.4 percent of the respondents heard the information on CA. Paulson (1995) conducted a study to evaluate such training programmes and found that their lack of

effectiveness was caused by the top down approach that defined them, which failed to consider smallholder farmers' beliefs, values, and previous knowledge. She concluded that "success of educational programmes in sustainable agriculture will depend on the knowledge, beliefs, and values the student brings to them" (Paulson 1995:122).

According to Rogers (2003), social networks and systems which include support systems such as a local farmer organization or association and the type and amount of interaction with professionals following the educational intervention are relevant to the diffusion of innovations framework and have influence on adoption decisions. For every innovation, constant training of those practicing the innovation is cardinal. This helps to monitor how people are adopting and adapting an innovation and to what extent. This helps to reduce the number of those disadopting and those likely to disadopt the innovation. All change agents are supposed to complete training in sustainable agriculture to improve their understanding, competence, and ability to teach or communicate the concept (Agunga, 1995). All agricultural professionals from extension agencies are also expected to have training in sustainable agriculture (Agunga, 1995; Paulson, 1995). To enhance sustainability at the household level, Aune *et al.,* (2012) strongly felt that translation of extension materials such as leaflets into local languages and increasing their availability could enhance the competence of individual farmers in sustainable agronomic practices.

5.6.4 Options for Weed Control

Farmers acknowledge that herbicides are the most effective method of weed control however they are unable to access them. As an option to weed control challenge, 5.6 percent of the respondents suggested the use of herbicides (Figure 5.4). In one of the FGDs a discussant said that, *"the effective way to control weeds in CA tillage methods is the use of herbicides."* Focus group discussants suggested that the government should help have the cost of herbicides reduced so that they are affordable to all smallholder farmers. They further explained that with herbicides available very few if any, would disadopt CA with the reason of failure to control the weeds. Herbicides are very important if CA is to be practiced on larger areas and in reducing the numbers of those disadopting CA due to failure in weed control and management. Nyanga (2012:58) adds that "trainings on proper use of herbicides and potential harm of herbicides should be supported and encouraged among smallholder farmers."

5.6.5 Access to CA Incentives

Access to free incentives was cited by 28.9 percent of the respondents as a way to minimize disadoption of CA. Smallholder farmers who disadopted CA (81.5 percent) explained that there were no benefits in disadopting CA, they still hope to re-adopt but on condition that incentives were shared fairly for everyone to benefit.

Information obtained from one of the FGDs suggested the idea that effective monitoring and evaluation mechanisms of the scarce incentives could have an impact on the reduction of CA disadoption. Adequate and fair allocation of financial incentives, seed, fertiliser and other incentives, and constant evaluation of their impact, can generate positive results. Targeting farmers and change agents who are really interested in sustainability, who need the economic help, and who can maximize the impact of such scarce resources, can lead to the wise use of incentives.

The discussants further said that supply of mineral fertiliser, improved seeds, herbicides, pesticides and credit facilities can have a decisive role with regard to the continuity in practicing of CA among smallholder farmers in Zambia. This implies that there is need to improve on the provision of the incentives. Donors and CA promoters should select a manageable number of villages where they can operate from and where they can manage to provide incentives to all those involved in the project.

5.6.6 Leadership and location

Results show that 8.9 percent of the respondents cited the need for good local CA leadership performance especially from the lead farmers for they are the ones that interact with the promoters and distribute the incentives (Table 5.4). Some discussants in a FGD explained that there was need for the donors to deal with the farmers directly instead of using the *"selfish"* lead farmers who just bring confusion.

The study has shown that transportation of manure, labour intensity, lack of adequate knowledge in CA, weed control, lack of incentives and poor local CA leadership influence smallholder farmers to disadopt CA. These factors answered the first objective of the research which was seeking to identify the factors that contributes to disadoption of CA among smallholder farming households in the study area and the research question seeking to find out the socio-economic factors that contribute to disadoption of CA. Further the research question

seeking to find out the disadoption rate was answered by the findings that 29.3 percent of smallholder farmers disadopted CA, 21.8 percent were still practicing CA and 48.9 percent never adopted CA.

The second objective and research question was seeking to identify opportunities and options for addressing the challenges faced by smallholder farmers that lead to CA disadoption. These were achieved in the findings that the most common options cited to minimize disadoption are access to CA incentives, enhanced CA training and access to transport for manure. The least suggested option for minimizing disadopting was herbicide usage as shown in figure 5.4. The hypothesis was answered in that there was statistically significant evidence that CA disadoption was associated with high labour demand, lack of free incentives, lack of transport for manure and poor local CA leadership.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study aimed at assessing CA disadoption amongst smallholder farmers in Petauke using mixed methods. The study showed that the most disadopted CA practices among the smallholder farmers in the study area are the CA basins followed by ripping. There was statistically significant evidence supporting the hypothesis that CA disadoption was associated with high labour demand, lack of free incentives, lack of transport for manure and poor local CA leadership. Further the study showed that the factors that contributed towards increased likelihood of CA disadoption were lack of transport for manure; lack of adequate knowledge in CA; location and lack of free incentives (material items given). These factors were statistically significant at 0.05 level of significance whilst others such as high labour demand; poor local CA leadership; gender and lack of CA tillage equipment (especially the ripper) were not.

From the smallholder farmers' perceptions, options for reducing the disadoption of CA were increased access to free incentives including herbicides; enhanced CA training; increased access to transportation of manure; provision of CA equipment and good local CA leadership. Thus this study concludes that most of the factors that influence disadoption involve the attitude of the farmers, dependency on the incentives, labour constraints, poor rapport between local CA leadership and smallholder farmers, and lack of essential assets.

6.2 Recommendations

This study therefore recommends the following:

1. Smallholder farmers should be trained by the donors and CA promoters to become self-reliant in terms of inputs either through livelihood diversification and change in their mindset so as to reduce dependence on free incentives.
2. Among the donors and CA promoters the approach for promoting CA and its introduction among smallholder farmers should be based more on scientific evidence than based on material incentives to lure farmers to adopt CA.
3. There is need to increase access to extension services so as to enhance CA trainings to smallholder farmers by both public and non-public actors such as the Ministry of Agriculture and Livestock, and the Conservation Farming Unit. This is essential to build the knowledge base and skills in CA among smallholder farmers.

4. There is need to enhance local ownership of CA practices so as to have continued practice beyond project periods.
5. Commercialization of rippers through small and medium enterprises and local artisans should be encouraged and funded by donors, CA promoters and Government so as to increase the access to the rippers by smallholder farmers.

6.3 Future Research

This study assessed CA disadoption amongst smallholder farmers in Petauke but did not look at the effects of CA disadoption on household food security. This is an aspect which other researchers can consider exploring.

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APPENDICES

APPENDIX I

Questionnaire for survey on Conservation Agriculture 2013/2014

Section A Identification (To be filled in by the enumerator at the start of the interview)

1. Questionnaire code: _____ Agricultural camp:_____
2. Village: _____ Date of Interview __/__/2014
3. Respondent's name (s): _____
4. Type of household head ☐ Male Headed ☐ Female Headed
5. Number of Family Members ☐
6. Age _____
7. Level of Education of the Head of Household _____

Section B Adoption and attitudes related to conservation farming

8. Have you ever heard about conservation farming? Yes/No _____
9. If Yes above, which is your **most important** source of information on conservation farming?
   ☐ Radio/Television ☐ The Conservation Farming Unit (CFU) ☐ Fellow Farmers
   ☐ Another source, which one? _____ ☐ Haven't heard about it
10. Are you a practicing farmer of CA? Yes/No.____
11. Did you disadopt CA? Yes/No/Never adopted _____
12. If the answer for question 11 is (Yes), when did you disadopt CA?----------
13. Which CA practices did you disadopt, please specify? ----------
    ----
14. State reasons/factors why you disadopted the specified CA practices or why farmers disadopt CA.----------
    What possible solutions do you think can help minimize/stop disadoption of CA.----------
    ----
15. Have you attended any CFU training sessions over the past 12 months? Yes/No.___
16. If Yes above, how many times? ____ and what type of training_____
17. Please could you state the type of assets that you have at your farm and their quantities.

ASSETS	Cattle	Plough	Ridger	Chaka hoe	Ripper	Tractor	Tractor Ripper
QUANTITY							

18. Please could you state the weeding method that your **household** used this farming season 2013/2014? _____

19. State reasons for using the selected weeding method.

_____

Section C Institutional Aspects

20. Have you been visited by extension officers during the past 12 months? Yes/No.
21. If Yes for question 21, how many times? _____
22. List the limitations/challenges that you have experienced in the following and the possible solutions to the challenges:

    CF

    basins_____

    Solution_____

    Conventional hand

    hoeing_____

    Solution_____

    Ripping_____

    Solution_____

    Ploughing_____

    Solution_____

    Disadoption of CA _____

    Solution_____
23. Are there incentives given to those practicing CA? Yes/No.
24. If Yes for question 24, list the types of incentives given_____
25. Do you hope to continue practicing CA? Yes/No.

    If Yes, explain_____

    If No, explain_____
26. Do you hope to continue disadopting CA? Yes/No.

    If Yes, explain_____

    If No, explain_____

The end, thank you very much and God bless you and family.

APPENDIX II

Interview Guide for the Focus Group Discussion

1. Have you ever heard of smallholder farmers disadopting CA?
2. If 'Yes' to the above question, which CA tillage are the smallholder farmers disadopting?
3. State reasons/factors you think contribute to disadoption of the named CA tillage in question two among smallholder farmers.
4. What possible solutions do you think can help minimize/reduce disadoption of CA?
5. Are there any benefits that smallholder farmers attain after disadopting CA?
6. Are there incentives given to those practicing CA?
7. What types of incentives are given to the smallholder farmers practicing CA?
8. Do the smallholder farmers who disadopt CA hope to readopt CA?

The End.

Thank you very much.

APPENDIX III

Interview Guide for the Key Informants

1. Have you ever heard of smallholder farmers disadopting CA?
2. If 'Yes' to the above question, which CA tillage are the smallholder farmers disadopting?
3. State reasons/factors you think contribute to disadoption of the named CA tillage in question two among smallholder farmers.
4. What possible solutions do you think can help minimize/reduce disadoption of CA?
5. Are there any benefits that smallholder farmers attain after disadopting CA?
6. Are there incentives given to those practicing CA?
7. What types of incentives are given to the smallholder farmers practicing CA?
8. Do the smallholder farmers who disadopt CA hope to readopt CA?

The End.

Thank you very much.