

**FACTORS AFFECTING THE ADOPTION OF CONSERVATION AGRICULTURE  
AMONG SMALL SCALE FARMERS IN ZAMBIA'S MUMBWA DISTRICT**

**A Research Report presented to the Department of Agricultural Economics and Extension  
of the University of Zambia.**

**BY**

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## LIST OF ACRONYMS



<b>ADP</b>	Animal Draft Power
<b>AGORA</b>	Access to Global Online Research in Agriculture
<b>AIDS</b>	Acquired Immune Deficiency Syndrome
<b>CA</b>	Conservation Agriculture
<b>CF</b>	Conservation Farming
<b>CFU</b>	Conservation Farming Unit
<b>CSO</b>	Central Statistical Office
<b>CT</b>	Conservation Tillage
<b>FAO</b>	Food and Agriculture Organization
<b>FO</b>	Field Officer
<b>GART</b>	Golden Valley Agricultural Research Trust
<b>HIV</b>	Human Immunodeficiency Virus
<b>IRT</b>	Improved Reduced Tillage
<b>MAL</b>	Ministry of Agriculture and Livestock
<b>MGDs</b>	Millennium Development Goals
<b>MT</b>	Minimum Tillage
<b>SPSS</b>	Statistical Package of Social Sciences
<b>SSA</b>	Sub-Saharan Africa
<b>ZMK</b>	Zambian Kwacha
<b>IMCS</b>	Independent Management Consulting Services
<b>CAP</b>	Conservation Agriculture Program

## ABSTRACT

### **Factors Affecting the Adoption of Conservation Agriculture among Small Scale Farmers in Zambia's Mumbwa District**

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Adoption of Conservation Agriculture (CA) is quite low in most parts of Zambia as compared to Conservation Farming (CF). However, there has been more research on the factors affecting the adoption of CF and less on factors affecting the adoption of CA. This study was conducted to identify the factors affecting the adoption of CA as well as determining the extent of CA adoption among small scale farmers in Mumbwa. Primary data was collected using structured questionnaires from a stratified random sample of 98 small scale farmers in Mumbwa main area, one of Conservation Farming Unit (CFU) coverage area.

In order to determine the factors that affect the adoption of conservation agriculture, the Probit model was used to determine what effect sex, marital status, level of education and age of household head, cattle ownership, number of CA trainings, availability of *Musangu tree* seedlings, size of household, farm size and household income has on the adoption of CA from the 98 sampled farmers. Results show that there is a statistically significant relationship between sex and marital status of the household head and the adoption of CA at 95% confidence interval. This is because the p-values for both marital status (0.013) and sex (0.002) were below 0.05. Both females and being married increases the probability of conservation agriculture adoption.

Because the Probit model does not determine the extent of CA adoption, the Tobit model was used to determine the extent of CA adoption among the 49 conservation agriculture adoptors of the sample size. The regression results of the Tobit model show that in addition to marital status and sex of the household head, farm size and number of CA trainings a farmer attends are important determinants of the extent of adoption of CA. On the one hand, sex and marital status of household head and number of CA trainings were significant at 95% confidence interval with p-values of 0.021, 0.042 and 0.01 respectively. On the other hand, farm size had a p-value of 0.064 which was less than 0.1 and was therefore statistically significant at 90% confidence interval. While there is a positive relationship between females and CA adoption, between being married and CA adoption and between the number of CA trainings and CA adoption, there is an inverse relationship between farm size and the extent of CA adoption. The higher the farm size the less likely that a farmer will engage in CA technology practices. There is therefore need to intensify CA trainings among small scale farmers by the conservation farming unit (CFU) field officers.

## CHAPTER ONE INTRODUCTION

### 1.1 Background

Agriculture is the main source of income for the majority for rural households in Zambia (Kabwe and Donovan, 2005). However, the majority of Zambia's small scale farmers is poor and experience lots of hardships as a result of decreased land productivity (Kabamba and Muimba-Kankolongo, 2009). The decrease in productivity has greatly been attributed to a number of factors. These factors include soil degradation due to long term practices of low input agriculture and poor farming systems associated with government policy of subsidized chemical fertilizer for maize production (Kabamba and Muimba-Kankolongo, 2009). These factors in turn have resulted in declining crop yields, poverty and food insecurity. Due to continuous heavy application of chemical fertilizer application and unsustainable extensive land plowing systems, Zambia's agriculture recorded significantly declines in land quality and productivity in the 1990s (Haggblade and Tembo, 2003a; Rockstrom *et al*, 2008).

In order to address the problems of soil degradation and reduced crop productivity, several actors emerged in the development of improved agricultural technologies during the 1980-1990s (Kabamba and Muimba-Kankolongo, 2009). These technologies include Conservation Farming (CF) and Conservation Agriculture (CA).

These terms, conservation farming and conservation agriculture, have often been used interchangeably in various literatures (Mazvimavi and Twomlow, 2009). However, the two terms are different. The terminology CA as defined by the main advocate of improved agricultural technologies, Conservation Farming Unit (CFU) has been adopted for the purpose of this paper. Conservation Farming Unit, define CA as "farming practices that involves all of the following: dry-season land preparation using minimum land tillage using either ox-drawn rip lines or hand-hoe basins laid in 16,000 basins per hectare, crop residue retention of at least 30%, seeding and input application in fixed planting stations, crop rotation with nitrogen-fixing legumes of at least 30% of the cropped area and planting of *Musangu tree (faidherbia albida)* in the fields" (Haggblade and Tembo, 2003b; CFU, 2009a; Baudron, 2007; CFU, 2011).

On the other hand, CF refers to the farming practices that involve dry-season land preparation using minimum land tillage using either ox-drawn rip lines or hand-hoe basins laid in 16,000 basins per hectare, crop residue retention of at least 30%, seeding and input application in fixed planting stations, crop rotation with nitrogen-fixing legumes of at least 30% of the cropped area (Haggblade and Tembo, 2003b; CFU, 2009a; (Mazvimavi and Twomlow, 2009); CFU, 2011). The major difference between CA and CF is that the former involves planting of *Musangu trees* while the later does not involve planting of *Musangu trees* (CFU, 2009a).

With the planting of *Musangu trees (faidherbia albida)*, fertility accumulation under a fully grown *Musangu tree* canopy, through leaf and pod fall, nitrogen fixation and association with soil microorganisms, is reported as follows: 75kg N, 27kg P<sub>2</sub>O<sub>5</sub>, 183kg CaO, 39kg MgO, 19kg K<sub>2</sub>O and 20kg S which is equivalent to 300kg of chemical fertilizer and 250kg of lime (CFU, 2009a). The method is appropriate in agro-ecological regions I and II in Zambia where rainfalls are from less than 800mm up to 1000mm (Langmead, 2003b).

Since the introduction of CA in Mumbwa, the adoption rate has been low. Little information is known about the factors that affect the adoption of CA in Mumbwa. However a handful of researches have been carried out on conservation farming. Haggblade and Tembo (2003a), Kabamba and Muimba-Konkolongo (2009) identified some of the factors that affect the adoption of CF. These factors include cattle ownership, personal characteristics, field size gender, household size, level of education and age. None of these researches had looked at the factors that affect the adoption of CA in Mumbwa district. This paper therefore, was aimed at identifying the factors affecting the small scale famers' adoption of CA.

## **1.2 Problem Statement**

Agriculture along with tourism and mining are considered as the main drivers of the Zambian economy. However, the major challenges in agriculture is to reverse trends of soil fertility depletion or soil degradation and soil desiccation in Sub-Saharan Africa (SSA), Zambia inclusive, where 65% of agricultural land is subject to soil depletion (Giller *et al*, 2009; Rockstrom *et al*, 2008). This degradation contributes to low yield and low productivity (Rockstrom *et al*, 2008).

Conservation agriculture however is claimed to be a panacea for the problem of agricultural productivity in SSA (Giller *et al*, 2009). Sustainable increase in agricultural productivity is necessary to secure adequate food availability (food security) and improve livelihood in developing countries (Erenstein, 2003). CA in SSA, where the largest challenge of undernourishment and poverty prevail, can enable countries to achieve the United Nations Millennium Development Goals (MDGs) of halving the population of the poor and hungry in the world by 2015 (Rockstrom *et al*, 2008). A few studies which have compared output between CF and Conventional Tillage (CT) have found that CF often double output compared to those achieved under conventional tillage (Haggblade and Tembo, 2003a). Mazvimavi and Twomlow (2009) report that yield gains in Zimbabwe among CF farmers ranges between 10-200%.

Though there are evidences in yield increase among small scale CF and CA farmers than those of CT, these increases would be even higher by applying fertilizer in their fields. However, most of these small scale farmers can not afford to buy the required amount of fertilizer. Even some of these farmers that have received some fertilizer from the Farmer Input Support Program (FISP), which is not enough, have failed to realize the full increases in yield under CF due to late distribution of farming inputs by the government. The planting of *Musangu tree*, which is nicknamed the “the fertilizer tree”, has the great potential to reduce the amount of chemical fertilizers applied by small scale farmers (GART, 2010).

Though evidence shows that about 78 000 farmers had adopted CF in 2001/2 farming season (Haggblade and Tembo, 2003a), and about 102 800 farmers in 2011/12 farming season (Independent Management Consulting Services (IMCS), 2012), many small scale farmers have failed to adopt CA in Zambia despite concerted efforts from the advocates of CA such as the Conservation Farming Unit (CFU). The number of CA adopters has been relatively low and IMCS (2012) reports that only 7 200 had adopted CA during 2011/2012 farming season as compared to 102 800 CF adopters. Even in areas where farmers are practicing CA, the adoption rate of CA basins and ripping vary dramatically across agro-ecological regions, provinces and even within individual districts, Mumbwa inclusive.

The adoption of CA in Mumbwa is still low. According to the Broad-Based Survey (BBS) conducted by Independent Management Consulting Services (IMCS) in 2011 for Conservation Agriculture Program (CAP) II, only 35.1% of the hand hoe adopters and 30.4% of animal draft adopters had planted *Musangu* in their fields in the Western region which covers Mumbwa district (IMCS, 2012). Yet little information is known about the factors that affect its adoption in Mumbwa. However, there are many researches that have looked at CF and CT but have not looked at conservation agriculture, the practice that can benefit most of small scale farmers that can not afford to buy enough fertilizers. These researches include that of Rockstrom *et al* (2008), Mazvimavi and Twomlow (2009), Haggblade and Tembo (2003a). All these researches have looked at some components of CF but have not explored the factors that affect the adoption of conservation agriculture in Mumbwa. There is therefore little that is known about the factors that affect the adoption of conservation agriculture in Mumbwa. It is for this reason that this research sought to identify the factors that affect the adoption of Conservation Agriculture in Mumbwa.

### **3.3 Objectives**

#### **3.3.1 General Objective**

The general objective of the study was to identify the factors that affect the adoption of Conservation Agriculture (CA) among small scale farmers Mumbwa.

#### **3.3.2 Specific Objectives**

The specific objectives of the study were two fold.

- ❖ To identify the socio-economic and institutional factors that affect adoption of conservation agriculture among small scale famers in Mumbwa.
- ❖ To determine the extent of adoption of conservation agriculture among small scale farmers in Mumbwa.

### **1.4 Rationale**


Agriculture is the main source of livelihood for the majority of the rural households in Zambia and even when there has been some improvement in agricultural production, diversification and

cash cropping in the mid 1990s, small and medium farmers are still the largest group of the poorest in the country (Kabwe and Donovan, 2005). About 84% of these households exist below the national poverty line and 72% of the farm households are in extreme poverty (Kabwe and Donovan, 2005). In their research, they stated that combined small and medium scale farmers contribute about 60% of agricultural output. However, CA has the potential to increase production and productivity which can in turn make an important contribution to agricultural output and general economic growth of the country. Empirical analysis in the various country case studies shows that pro-growth and pro-poor performance of agriculture will continue to depend on the broad participation of small scale farmers and that food staple growth generates more poverty reduction than other non agricultural sectors do (Kabwe and Donovan, 2005). Through increased production and productivity, CA can improve the livelihood of these small scale farmers in Mumbwa. The factors that affect the adoption of CA need therefore to be investigated in order to come up with ways that will help increase the adoption of CA in presence of these factors are satisfied so that livelihood of these small scale farmers can improve and also contribute to the growth of the country's economy.

For policy makers, investments in the promotion of CA technologies meet poverty reduction only if the technologies are seen to benefit resource-poor farmers as well as those with more resources. Knowledge intensive technologies such as CA require greater educational and greater extensive efforts in order to be successful particularly with lower resource farmers. Apart from the partial fulfillment of undergraduate degree requirement, the research also sought to contribute to the knowledge of the factors affecting the adoption of CA in Mumbwa.

### **1.5 Organization of the Report**

This research report is divided into five (5) chapters and is arranged as follows. Chapter one highlights the background information about the research. It covers the problem statement, objectives and rationale of the study. Chapter two reviews CA related literature in which definitions of terms, researches conducted in Zambia, principles of conservation agriculture, types of conservation agriculture and researches conducted outside Zambia are discussed. Chapter focuses on the research methodology that was used for the study. It covers the



description of the study area, sampling procedures, research design, data collection, data analysis and limitations of the study. Chapter four presents the research findings and discussions while chapter five contains the conclusion and recommendations.

## **CHAPTER TWO LITERATURE REVIEW**

### **2.1 Introduction**

This chapter reviews relevant literature on conservation agriculture including its practices and factors that affect the adoption of conservation agriculture.

### **2.2 Definition of Terms**

Adoption is defined as a decision to make full use of an innovation as the best course of action once the individual has known and assessed the attributes of the innovation (Rogers, 2003).

Conservation Agriculture (CA) is clearly defined as a farming practices that involves all of the following practices: dry-season land preparation using minimum land tillage using either ox-drawn rip lines or hand-hoe basins laid in 16,000 basins per hectare, crop residue retention of at least 30%, seeding and input application in fixed planting stations, crop rotation with nitrogen-fixing legumes of at least 30% of the cropped area and planting of *Musangu* tree (*faidherbia albida*) in fields (Haggblade and Tembo, 2003a; CFU, 2009b; Baudron, 2007; Conservation Farming Unit, 2010).

Conservation farming can be defined as farming practices that involves the following practices: dry-season land preparation using minimum land tillage using either ox-drawn rip lines or hand-hoe basins laid in 16,000 basins per hectare, crop residue retention of at least 30%, seeding and input application in fixed planting stations, crop rotation with nitrogen-fixing legumes of at least 30% of the cropped area (Haggblade and Tembo, 2003a; Baudron *et al*, 2007; CFU, 2010).

### **2.3 Research Conducted in Zambia**

One of the researches conducted in Zambia include that of Haggblade and Tembo (2003a). However, the research was conducted on conservation farming in Zambia. The research was a type of adoption of improved technologies such as conservation agriculture. Since CA and CF are both improved technologies, the results of two scholars' research can be applied to the present study in determining factors that affect the adoption of CA in Zambia.

In their study, Haggblade and Tembo (2003a) identified a number of factors that affect the adoption of improved technology. These factors include cattle ownership and personal characteristics and plot size. The study revealed that in any given region, asset holdings of individual farmers will clearly influence their adoption decision of improved agricultural farming practices. The adoption of improved technologies does not just occur haphazardly, it involves series of successful steps in which an individual goes through before adopting an innovation. Conservation agriculture requires careful advance planning and precise timely execution of key tasks. It requires a change of thinking about management under which the dry season becomes no longer a time primarily reserved for socializing but rather an opportunity for land preparation work.

Conservation agriculture is based on several principles (CFU, 2009a; CFU, 2009b; Haggblade and Tembo, 2003a). These principles are what separate different components of improved farming practices: improved reduced tillage, (IRT) from conservation tillage (CT), Conservation Farming (CF) and conservation agriculture (CA) (CFU, 2009b; Haggblade and Tembo, 2003a; Baudron *et al*, 2007).

### **2.3.1 Principles of Conservation Agriculture**

- Retention of crop residues (30% of residues) in fields with no burning of residues.
- Restricting land tillage and nutrient application to the 10-15% of the surface area where crops are sown.
- Completion of land preparation during dry season.
- Establishment of a precise permanent grid of planting stations, furrows or contoured ridges within which successful crops are planted each year and within which purchased organic nutrients can be accurately applied.
- Crop rotation with a minimum of 30% nitrogen fixing crops in the system.
- Planting of *Musangu tree (faidherbia albiba)* at the spacing of 10m × 10m (100 *Musangu trees* in a hectare).

Chibbamulilo and Phiri (2000) in their research which was conducted in Northern and Southern provinces to identify significant socio-economic and institutional factors that affect the adoption of improved technology identified a number of factors. The following were the factors that the researchers investigated to determine their effect on the adoption of improved technology such as CA.

*Human Capital:* Factors such as education, skills training and experience in farming were examined to establish the human capital levels among respondents and their effect on education of new technology. The study revealed that the difference in education levels and agricultural skills were not statistically significant in the adoption of environmental friendly practices. However, farmer's experience was important in building human capital levels. The results showed a significant relationship between the adoption of some technologies and the number of years in farming which was used a proxy for measuring farmers' experience.

*Farm Human Resources:* Accessibility of capital is necessary for farmers to increase their productivity on the farm. The human resource base of the farmer which were looked at included cattle ownership and value of equipment on the farm such as hand hoes, axes, ox-drawn ploughs, ridgers and ox-carts among others. Both variables (cattle ownership and value of equipment on the farm) were statistically significant in the adoption of environmentally friendly farming practices.

*Gender:* The study revealed that there are significant differences between men and women in the adoption of some environmentally friendly practices. The study showed that women are more likely to adopt CF than men. There were fewer women with oxen and thus the majority of them were likely to use hand hoes in their farming rather than ox-drawn implements.

In another research carried out in Zambia by Nyanga (2012) in determining the factors influencing the adoption the area under conservation agriculture using a mixed model approach, identified that number of CA trainings attended, farm size, number of rippers owned and use of the area under CA. The study further revealed that women were very involved in conservation agriculture basins while prestige withholds some men from adopting CA basins.

### 2.3.2 Types of Conservation Agriculture

According to Nyanga (2012) there are two main variants of CA in Zambia. These are hand hoe based CA and Animal Draft Powered (ADP) CA (ripping). The third variant tractor or mechanized based CA is not common and it is usually used by medium or commercial farmers.

*Hand hoe Based CA:* Hand hoe based involves digging permanent planting basins spaced at 0.7 meters along the rows and 0.9 meters between rows using a *chaka hoe* (CFU, 2009b; Nyanga, 2012). In addition, crop residues and other vegetative matter are supposed to be retained on the surface as permanent organic matter soil cover in the area between the basins. The dimensions of a basin are 0.2 meters deep and 0.3 meters in length and 0.15 meters wide (CFU, 2009b; Nyanga, 2012). With the above specification of a basin and considering the area a hectare, it means that there will be 15, 850 basins which is usually approximated to 16,000 basins in a hectare for input calculations and recommendations. A *chaka hoe* is a type of hoe with an elongated thick strong blade and a long handle as compared to a traditional hoe. In addition, *chaka hoes* are heavier than the ordinary hand hoe. Basins improve water infiltration and harvest water which greatly contributes to output in areas and during years of erratic rainfall. Basins also permit greater precision in input application. Thus, basins facilitate management support and input supply by enabling support agencies to package inputs in standard one lima (0.25 hectares) packs (Haggblade and Tembo, 2003a). A picture of hand hoe based CA is shown in the appendix 2.

*Animal Draft Powered CA (ADP ripping).* This is the type of CA mainly used by those who have animal draft power. ADP ripping uses a *magoye ripper* (CFU, 2011; Nyanga, 2012). Instead of the complete soil inversion in conservational agriculture with a plough, farmers practicing ADP ripping make at least 0.15-0.20 meters deep ripped furrows (ripped lines) at 0.9 meters spacing (Nyanga, 2012). Just like hand hoe based CA, ADP ripping involves retention of crop residues and other vegetative matter between ripped lines (CFU, 2009a). Minimum tillage restricts soil disturbance to at least an area where the crop is sown which results in reduced soil disturbance to around 10% of the area in both CA basins and ADP ripping (FAO, 2011a) as opposed to about 100% soil disturbance especially in traditional plowing. Properly managed ripped lines offer similar gains as those offered by basins through early planting, improved infiltration and root

development, water harvest and greater precision and location of inputs (Haggblade and Tembo, 2003a).

*Mechanized CA.* Mechanized CA is similar to that of ADP ripping except that it is used at medium farmer level and mostly by commercial farmers. Usually, fertilizer and planting is done at the same time.

#### **2.4 Research Conducted Outside Zambia**

In a research conducted by Mazvimavi and Twomlow (2009) in Zimbabwe on socio-economic and institutional factors influencing the adoption of conservation farming by vulnerable households in Zimbabwe, a number of factors were investigated to determine their effect on adoption of conservation farming. Among the factors investigated in the study were farm size, availability of credit, access to information, labor constraint, rainfall region (agro-ecological region) institutional support, age and gender. The results from the study showed that institutional support and agro-ecological location had strong statistical influence on the intensity of adoption of different CF components such as timely post-planting weeding, top dressing with nitrogen fertilizers at 5-6 leaf level stage of the cereal crop and manure application in planting basins. Other factors such as availability of household labor and impact of HIV/AIDS however, did not have influence on the adoption of CF. The increased profitability in adopting CF on the other hand, had a considerable influence on the area each household committed to CF on average from an area of 1450m<sup>2</sup> to in 2004 to more than 2000m<sup>2</sup> in 2007.

The studies conducted by these scholars are a kind of improved technology adoption which can be applied to the factors affecting the adoption of conservation agriculture among the small scale farmers in Mumbwa.

#### **2.5 Conceptual Framework**

A binary logistic regression model was used in CA adoption to determine factors influencing adoption of CA. According to the diffusion of innovation theoretical perspective, a farmer's

response towards an innovation is binary, either adopts or rejects. Therefore, the model for CA adoption was specified as  $\text{Logit}(P(y=1)) = \log(P/(1-P)) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$

Where:

Y is a categorical response variable with 1=adopter and 0=otherwise.

$\alpha$  is the intercept.

$\beta_1, \beta_2, \dots, \beta_k$  are coefficients of independent variables  $X_1, X_2, \dots, X_k$ .

P is the probability of adopting CA.

(1-P) is the probability that a farmer does not adopt CA.

Since a farmer either had an area under CA (adopters) or no area under CA (non adopters) it was most appropriate to use a binary logistic regression model (Agresti, 2007; Nyanga, 2012) for the purpose of understanding factors explaining the likelihood of adoption of conservation agriculture.

However, the logistic regression does not assess the extent or the intensity of adoption. Hence, a Tobit regression (Adesina, 1993) model was used in explaining the area under *Musangu tree*. This was important because it provides additional information in identifying factors influencing the extent of CA adoption in terms of area under *Musangu tree*. This model was suitable because it made it easy to investigate the relationship between continuous variable (Area under *Musangu tree*) and some explanatory variable, some being continuous and others being categorical. The area under *Musangu tree* is influenced by a set of variables. The model for area under *Musangu tree* was specified as  $Y = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \epsilon_i$

Where:

Y is a continuous response variable (Area under *Musangu tree*).

$\alpha$  is the intercept.

$\beta_1, \beta_2, \dots, \beta_k$  are coefficients of the independent variables  $X_1, X_2, \dots, X_k$ .

$\epsilon_i$  is the error term.

i is the ith observation in the sample.

The variables, Xs, which were investigated in the study, are:

**Farm Resource Base Variable:**

Cattle Ownership

**Human Capital Variables:**

Level of Education of Household Head

Number of CA Trainings Attended

**Financial Capital Variables:**

Household Income

**Household Characteristics Variables:**

Sex of Household Head

Marital Status of Household Head

Farm Size

Age of Household Head

**Institutional Variable:**

Availability of *Musangu tree* Seedlings

## **CHAPTER THREE**

### **RESEARCH METHODS AND PROCEDURES**

#### **3.1 Introduction**

This chapter outlines the study area, research design, sampling design and procedures, data collection techniques and data analysis tools that were used in this research.

#### **3.2 Study Area**

The study was conducted in Mumbwa district which is located in the Central province of Zambia. Conservation Farming Unit (CFU) has been conducting trainings for farmers that want to engage themselves in CA and CF and has divided Mumbwa into eleven areas in which one field officer is responsible for conducting trainings and providing technical information and services to CF and CA farmers. In each area there are 30 lead farmers and each lead farmer has 10 farmers. The farmers sampled comprised of smallholder farmers from Mumbwa main area, one of the eleven areas which covers Mumbwa central block.

#### **3.3 Sampling Design and Procedures**

Stratified random sampling procedure was used. This involved listing all the farmers in Mumbwa main area practicing CA and those that do not practice CA. The list of CA farmers was obtained from Nawa Mubita, the field officer from Mumbwa main area while the list of non adopters (those not practicing CA) was obtained from the village headmen in the area. From the two lists, an equal number of farmers (i.e.49 farmers for adopters and 49 non CA adopters) were randomly selected to avoid over representation of the sample and therefore leading to erroneous interpretation of data. Thus, a sample of 98 farmers in total was randomly selected. Each farm household was treated as a sampling unit.

The formula given below was used to determine the sample size of 98 farmers.

$$N = t^2 \times p(1-p)/\varepsilon^2$$

Where:  $N$  is the sample size

$t$  is critical value (1.96) at 95% confidence interval

$\epsilon$  is the margin of error, 10% (0.1)

$p$  is the probability of adopting CA (0.5)

This formula gave the sample size of 96 farmers. However, two (2) farmers (one for the adopter and another one for the non adopter) were added to account for those farmers that could be difficult to locate during data collection.

### **3.4 Research Design**

The research design used in this study was a case study. A case study was used so as to have a deeper understanding of the factors affecting the adoption of CA and the intensity of the adoption of conservation agriculture among small scale farmers in Mumbwa district.

### **3.5 Data Collection Procedures**

The study used both primary and secondary data. Secondary data was mainly used to gain a broader understanding of the topic. The secondary data was collected from the Central Statistical Office (CSO), CFU, non-published and published data from Access to Global Online Research in Agriculture (AGORA) through the internet and other organization such as the Ministry of Agriculture and Livestock (MAL). However, for the purpose of analysis in this research, primary data was used. The primary data was collected from Mumbwa between 8<sup>th</sup> March and 28<sup>th</sup> May, 2013. The period was necessitated because it was the period when the researcher was on vacation period during which data could only be collected. Structured and pretested questionnaires were used to collect the primary data.

### **3.6 Data Analysis**

The coded primary data which was collected from the households was entered in Microsoft excel. The coefficients of the variables were estimated using Probit model in STATA. The data

from questionnaires was also analyzed using the statistical program for social sciences (SPSS) to generate tables, pie chart, and bar graph while the Microsoft excel was used to organize the outputs. Estimates of the extent of adoption were estimated by maximum likelihood method using the log-likelihood function in STATA.

### **3.7 Limitations of the Study**

Based on the method of determining the sample size of the respondents, the sample size of 98 was arrived at by increasing the margin of error from 5% to 10%. The research could not use the margin of error of 5% in which case the sample size would have been 384. Covering all the 384 farmers could not be feasible due to financial constraint. The other problem was that of poor record keeping by the farmers. This means that the researcher depended on recall data from the farmers to estimate quantities of inputs and their cost, yields, income and expenditure.

## **CHAPTER FOUR RESEARCH FINDINGS AND DISCUSSIONS**

### **4.1 Introduction**

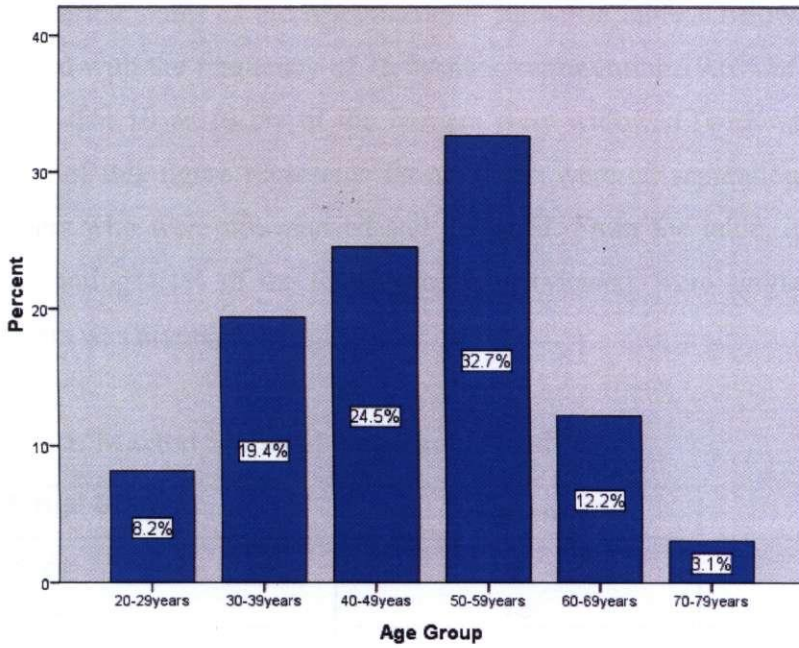
The chapter presents and discusses the findings of the study. It begins with the demographic characteristics of the respondents. It then presents the general findings of the study and ends with the presentation of the Probit regression and the Tobit regression results and interpretation of their results.

### **4.2 Demographic Characteristics of Respondents**

#### **4.2.1 Age Distribution of the Respondents**

Figure 1 below shows age distribution of the respondents. The figure shows that most (32 or 32.7%) of the respondents were in the age group of 50-59 years while the minority (3 or 3.1%) of them were in the age group of 70-79 years. The figure also shows that 19.4% (19) of the respondents and a about a quarter (24.5% or 24) of the respondents were in the age group of 30-39 years and 40-49 years respectively. In addition, 8.2% (8) of the respondents accounted for those that were in the age group of 20-29 years with a slightly above figure of 12.2% (12) being in the age group of 60-69 years. However, the minimum age of respondents was 21 and the oldest farmer was 72 years old. However, the average years of respondents was found to be 47.9 years.

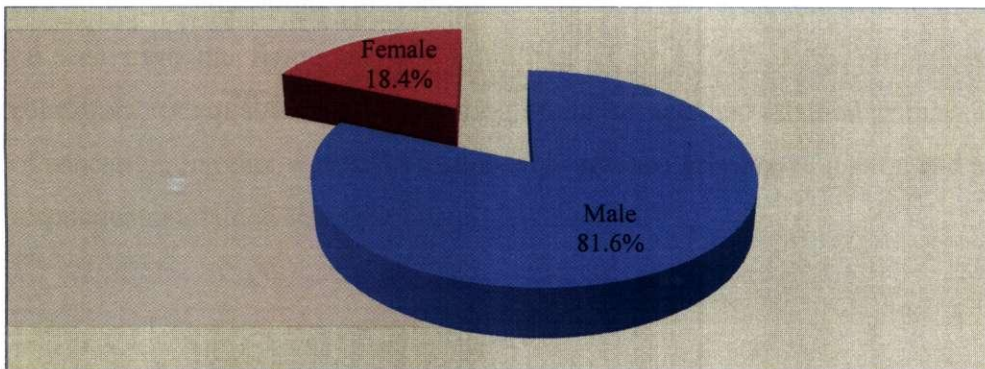
**Figure 1: Age Distribution of Respondents**



#### 4.2.2 Sex of Respondents

Figure 2 shows sex distribution of respondents. The figure reveals that the study comprised more male headed households than female headed households with males accounting for 81.6% (80 farmers) while females accounted for only 18.4% (18 farmers) of the total respondents.

**Figure 2: Sex Distribution of Respondents**



*Source: Own Field Data, 2013*

### 4.2.3 Marital Status of Respondents

The marital status of the respondents is shown in table 1 below. Most of the respondents were married with the frequency of 78 farmers, representing 79.6% of the respondents. The table also shows that 10 or 10.2% of the farmers were widowed (widows and widowers) and half (5 or 5.1%) of this figure represents farmers who were on separation. The sample also consisted of farmers who were not married and divorced. From the table, it can be shown that 4 farmers, representing 4.1% of the total farmers interviewed, were single while only one (1.0%) of the farmers was divorced.

**Table 1: Marital Status of Household Head**

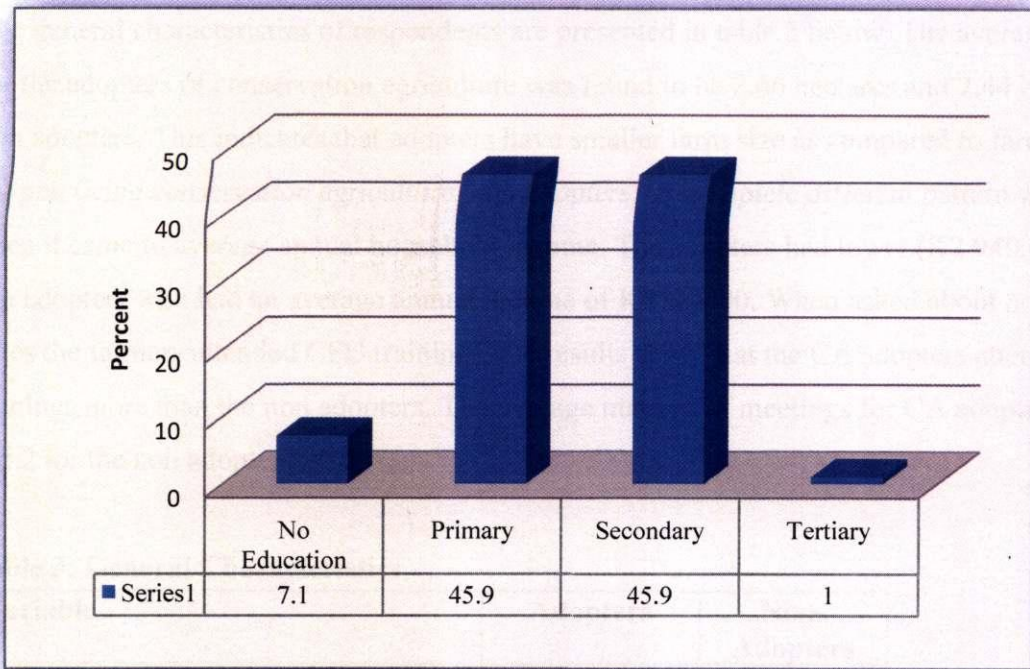
Marital Status	Frequency	Percent
Single	4	4.1
Married	78	79.6
Separated	5	5.1
Widowed	10	10.2
Divorced	1	1.0
Total	98	100.0

*Source: Own Field Data, 2013*

### 4.2.4 Level of Education of Respondents

Figure 3 below shows the education level of the farmers. From the figure, 7.1% of the farmers had no formal education. This represents 7 small scale farmers that were interviewed. It can also be seen from the figure that the minorities (1 or 1.0%) of the farmers had attained tertiary education. An equal (45.9%) proportion of the farmers had attained primary and secondary level of education. In other words, 45 respondents attained primary education and an equal number (45 respondents) attained secondary level of education.

**Figure 3: Level of Education of Household Head**



*Source: Own Field Data, 2013*

#### 4.2.5 Cattle Ownership

Table 2 given below shows cattle ownership of respondents. The table illustrate that 48 respondents owned cattle. This represents 49.0% of the respondents. On the other hand, 51.0% or 50 small scale farmers interviewed did not own cattle.

**Table 2: Cattle Ownership**

		Frequency	Percent
Cattle Ownership	Yes	48	49.0
	No	50	51.0
Total		98	100

*Source: Own Field Data, 2013*

### 4.3 General Characteristics

The general characteristics of respondents are presented in table 3 below. The average farm size for the adopters of conservation agriculture was found to be 2.66 hectares and 2.44 hectares for non adopters. This indicates that adopters have smaller farm size as compared to farmers that are not practicing conservation agriculture, non adopters. A complete different pattern was observed when it came to average annual household income. The adopters had lower (K2 940.00) than the non adopters who had an average annual income of K3 688.00. When asked about how many times the farmers attended CFU trainings, the results show that the CA adopters attended CFU trainings more than the non adopters. The average number of meetings for CA adopters was 3 and 2 for the non adopters.

**Table 3: General Characteristics**

<b>Variable</b>	<b>Adopters</b>	<b>Non-Adopters</b>
Average Farm Size	2.66	2.44
Average Household Annual Income	K2,940.00	K3,688.00
Average Number of CA Trainings	3	2

*Source: Own Field Data, 2013*

### 4.4 The Probit Regression

The Probit model regression results shown in table 4 were done for a total of 98 observations from the sample survey. The model was significant at 0.05 as the p-value (0.0219) of the model was found to be less than 0.05. The goodness of fit of the model was found to be 0.205 meaning that 20.5% of variations in the dependent variable are explained by the independent variables. The results are shown in table 4 below.

**Table 4: Parameter Estimates of the Probit Regression (Dependent Variable: Whether someone has *Musangu tree* in the field or not).**

Variable	Marginal effect	Standard Errors	P-value
Intercept	1.71108	0.5778	0.004
Age of Household Head	-0.00282	0.0044	0.525
Sex of Household Head	-0.6781	0.20694	0.002***
Marital Status of Household Head	0.02694	0.1064	0.013***
Farm Size	-0.1118	0.5922	0.162
Size of Household	0.00824	0.0148	0.579
Level of Education of Household Head	0.11866	0.08315	0.152
Cattle Ownership	0.1563	0.1227	0.206
Household Income	0.03742	0.0242	0.125
Availability of <i>Musangu tree</i> Seedlings	-0.01689	0.1841	0.373
Number of CA trainings	0.00289	0.00255	0.262

*Source: Own Field Data, 2013* \*\*\* significance level= 95%

From the table, the factors that affect the adoption of conservation agriculture among the small scale farmers are sex and marital status of household head.

The sex of the respondents was found to be statistically significant in explaining the adoption of conservation agriculture as the p-value (0.002) is less than 0.05. Thus, sex of household head is significant at 95% confidence level. From table 4 above, the marginal effect for sex of household head is -0.6781. The negative sign indicates a reduction in the probability of adoption of CA. Since sex was entered as dummy variable for men, the results entail that as compared to females,

being male reduces the probability of adopting CA by 67.8%. This could be due to the fact that in most societies land preparation is mainly done by females and CA land preparation is done during dry season. During this period, men would be busy with other jobs which would hinder them from participating in dry land preparation hence the reduced probability of the adoption of CA. The results are consistent with those of Chibbamulilo and Phiri (2000) in their research conducted in Northern and Southern province of Zambia who established that women are more likely to adopt Minimum Tillage (MT)/Conservation Tillage (CT) than men.

Marital status of respondent can be influential on the probability of adoption of improved conservation practices including CA; it was significant at 95% confidence interval (p-value <0.05). The p-value was found to be 0.013. The results of the study show that being married increases the probability of the adoption of conservation agriculture as indicated by the positive value of the marginal effects (0.02694). Just like sex of the household head, marital status was entered as a dummy variable (married) which separated those married farmers from those that are not married. The marginal effect indicates that being married increases the probability of adoption of conservation agriculture by 2.69% compared to those that are not married. This could be because of the fact that if a farmer is married resources such as labor and other material resources may increase enabling the farmer to engage in highly argued labor intensive CA.

#### **4.5 The Tobit Regression**

The Tobit model was estimated using maximum likelihood estimator in STATA from the data collected from the respondents in Mumbwa. Table 5 presents the Tobit regression (adjusted for heteroskedasticity) parameters for the adoption of CA. The dependent variable is the area under *Musangu trees*. The log likelihood of the model was -68.541 and was done for 49 observations of the farmers that adopted the CA. The adjusted R-squared was 0.756. This means that 75.6% of the variations in the dependent variable are explained by the independent variables.

**Table 5: Tobit Regression Parameter Estimates for the Extent of Adoption of Conservation Agriculture (Dependent Variable: Area under *Musangu tree*).**

Variable	Marginal effect dy/dx	Standard Errors.	p-value
Intercept	1.599	0.184	0.023
Age of Household Head	-0.00505	0.5326	0.556
Sex of Household head	-1.782	1.41E-03	0.021***
Marital Status of Household Head	0.7113	0.0547227	0.042***
Farm Size	-0.2109	0.00242	0.064**
Size of Household	0.0109	0.04006	0.627
Level of Education of Household Head	0.2499	0.08685	0.112
Cattle Ownership	0.2781	0.0596003	0.249
Household Income	0.05166	0.045602	0.217
Availability of <i>Musangu tree</i> Seedlings	-0.3629	0.0959625	0.203
Number of CA trainings	0.011651	0.06539	0.01***

Source: Own Field Data, 2013 \*\*\*significance level= 95% \*\* significance level 90%

The sex of household head was found to be significant at 95% in the adoption extent of CA as the p-value (0.021) was less than the critical point of 0.05. The study shows that compared to females, being male reduce the allocation of area to *Musangu trees* by 1.782 hectares. The relationship is as already explained above in part 4.4.

Marital status of respondent was also found to be statistically significant in explaining the extent of adoption of conservation agriculture technologies at 95% confidence interval. This is because the p-value (0.042) is less than 0.05. The positive value of the marginal effect (0.7113) shows that being married increases the allocation of land to *Musangu trees*. The marginal effect of marital status of the respondent indicates that being married increases the allocation land to *Musangu trees* by 0.7113 hectares as compared to those that are not married.

The marginal effect of farm size (-0.2109) indicates that farm size affects the extent of adoption of conservation agriculture. However, this is only true at 90% confidence interval as signified by the p-value (0.064) which is less than 0.1. The negative sign indicate a negative effect of farm size on the extent of CA adoption. The effect on the extent adoption of CA by farmers is such that an increase in farm size of the farmer by a hectare reduces the adoption of CA by 0.2109 hectares. The argument presented by Haggblade and Tembo (2003a) about labor intensity nature of CA can be used to explain the observed relationship. Larger farm size would mean more work on the household members and to reduce the work load, the household would rather not adopt CA and continue with the traditional way of farming which is perceived to be less laborious.

Though a weak relationship, the number of CA trainings that a farmer attends in a year has a significant effect on the adoption of CA. This is true at 95% confidence interval as the p-value (0.01) is less than 0.05. The marginal effect indicates that an increase in the number of CA trainings by one, the allocation of land to *Musangu trees* increases by 0.011651. This emphasizes on the role that a field officers play in the extent of adoption of conservation agriculture. They provide assistance and technical advice to the farmers and lack of this advice and technical assistance reduces the extent of adoption of CA.

## CHAPTER FIVE CONCLUSION AND RECOMMENDATIONS

### 5.1 Introduction

Chapter five presents the conclusion and recommendations of the study based on the findings of the study.

### 5.2 Conclusion

Conservation agriculture (CA) provides a system that enables farmers to be timely, accurate and efficient and its adoption among small scale farmers forms an important aspect of it. Efficiency will translate into improved yields and productivity which will ensure food security and increased income among small scale farmers.

The study was designed to determine the factors that affect the adoption of CA among small scale farmers in Mumbwa and to determine the extent of adoption of CA in Mumbwa. In order to accomplish these objectives, the study reviewed a number of literatures in order to gain a broader understanding of the study. The study thus used both primary and secondary data. Secondary data was obtained from various organizations. However, for the purpose of analysis, primary data was collected using the structured questionnaires. Quantitative analytical tools were used to determine the effects of age, sex, marital status of respondents, cattle ownership, availability of *Musangu tree* seedlings, number of trainings, farm size, household income, household size and level of education of respondents on the adoption and extent of adoption of CA.

The study revealed that sex and marital status of respondents were statistically significant factors affecting the adoption of conservation agriculture. As compared to males, female farmers increases the probability of adoption of CA while being married increases the probability of adoption of CA compared to those that are not married. It was also found that these two factors (sex and marital status of the respondents) along with farm size and number of CA trainings a farmer attends had an effect on the extent of adoption of CA. Apart from increasing the probability of CA adoption, being female and being married also increases the extent of the

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## APPENDICES

**Appendix 1: Questionnaire**

**Factors Affecting the Adoption of Conservation Agriculture among Small Scale Farmers of  
Zambia's Mumbwa District**

Questionnaire Number.....

---

**SECTION A: BACKGROUD INFORMATION**

Q1.What was your age as at last birthday?

Q2.Who makes most of decisions in the family?

(1)Mother

(2)Father

(3)Brother/Sister

(4)Grandparents

Q3.Sex of household head

(1)Male

(2)Female

Q4.Marital status

(1)Single

(2)Married

(3)Separated

(4)Widowed

(5)Divorced

Q5.Highest education level attained by Household head

(1)No education

(2)Primary

(3)Secondary

(4)Tertiary

Q6. What is your household size by indicating the following?.....

(1)School going children.....

(2)Non School going children.....

(3)No. of spouses.....

(4)Other dependants.....

Q7. How many hectares is your farm altogether?.....

Q8. How many hectares of this farm do you cultivate? Indicate the following?

(1)Area for Maize.....

(2)Area for Cotton.....

(3)Area for groundnuts.....

(4)Area for other crops.....

Q9 Household annual income (ZMK)?.....

Q9a. Annual income from crop sale.....

Please indicate the crops you grew last farming season?	How much did you harvest?	Did you sell any of this Crop? 1=Yes 2=No → Go to next crop	How much did you sell?	Average price per unit?	Total income?
Q9a. Total crop sales					

Q9b. How much did you earn (ZMK) last year from the following?.....

- i. Livestock sold.....
- ii. Grants/gifts.....
- iii. Gardening.....
- iv. Forests.....
- v. Others.....

Note: the summation of Q9a and Q9b together form Q9 (Annual III income)

Q10. Do you own cattle?

- (1) Yes
- (2) No

Q11. If yes please indicate the number of pairs of cattle that you use for farming?

**SECTION B: OTHER INFORMATION**

Q12. Do you know *Musangu tree*?

- (1) Yes
- (2) No

Q13.If yes, what is the most important source of information on *Musangu tree*?

- (1) Radio
- (2) Television
- (3) Conservation Farming Unit (CFU)
- (4) Fellow farmer (specify).....

Q14.Has any of the above encouraged you to grow it?

- (1) Yes
- (2) No

Q15.Do you have planted *Musangu trees* in your field?

- (1)Yes
- (2)No

Q16. What are the reasons why people do not plant *Musangu tree* in their fields?

Yes      No

- |   |                          |                          |
|---|--------------------------|--------------------------|
| A. Don't know <i>Musangu tree</i> .   | <input type="checkbox"/> | <input type="checkbox"/> |
| B. Don't know its use.  | <input type="checkbox"/> | <input type="checkbox"/> |
| C. It's difficult to grow <i>Musangu tree</i> .                               | <input type="checkbox"/> | <input type="checkbox"/> |
| D. The soils on my farms are not suitable for <i>Musangu tree</i> growth.     | <input type="checkbox"/> | <input type="checkbox"/> |
| E. There is no difference in yield with those that have <i>Musangu tree</i> . | <input type="checkbox"/> | <input type="checkbox"/> |
| F. <i>Musangu</i> seedlings/seeds are unavailable.                            | <input type="checkbox"/> | <input type="checkbox"/> |

Q17.Have you ever attended any CA/CF trainings by CFU?

- (1)Yes
- (2)No

Q18.If yes, please indicate the number of trainings in a year.....

*Thank you for your Cooperation*

**Appendix 2: Hand Hoe Based Conservation Agriculture Picture**

