

**FACTORS AFFECTING THE ADOPTION OF STRIP TILLAGE PRACTICES IN
ZAMBIA'S CHOMA 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 ABBREVIATIONS

CA	Conservation Agriculture
CF	Conservation Farming
CFU	Conservation Farming Unit
DAC	District Agriculture Coordinator
FAO	Food Agriculture Organization
FSP	Fertilizer Support Program
GVART	Golden Valley Agricultural Research-Trust
NGO	Non-Governmental Organization
SPSS	Statistical Package for Social Sciences

ABSTRACT

Factors Affecting the Adoption of Strip Tillage Practices in Zambia's Choma District.

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The main objective of this study was to assess the factors that affect the adoption of strip tillage practices among smallholder farmers in Choma district, Southern province of Zambia. And further to determine the extent to which each factor identified affects adoption. The structured questionnaire was the primary instrument used for data collection and also informal interviews on the sample surveyed. Descriptive statistics were generated using SPSS. Excel was used to organize Outputs. Estimates of the parameters β and σ were obtained using Tobit model in STATA. This model was used to identify the factors that motivate the level and intensity of adoption of strip tillage practices in Choma district. This thesis considered explanatory variables like the level of education, the size of family, risk sensitivity represented by size of farm operations and off farm income; access to financial capital represented by farm size, human capital represented by demographic variables like age, gender and marital status; and physical capital represented by total value of assets. The results showed that adoption of strip tillage is explained by farm size (p-value=0.015), the age of the farmer (p-value=0.036), education level of the farmer (p-value=0.000), and access to technical (p-value=0.017), and credit services (p-value=0.005).

In line with these findings, researchers should continue to develop technologies that could be adopted by farmers for the purpose of high productivity gains. In addition, efforts should be made by scientists to design institutional arrangements that will facilitate technology to flow up to the farmers. The government should also employ enough agricultural extension officers so that they can adequately provide technical assistance necessary for adoption of a new technology.

CHAPTER ONE

BACKGROUND

1.1 Introduction

The high rate of population growth in Zambia requires an ever increasing production of stable foods. This however stands in sharp contrast with the declining food production due to declining soil fertility mainly due to poor farming practices. However, Small-scale farmers in Zambia have the potential to produce sufficient food for home consumption and domestic market. In order to improve food production, which also increases household income and food security, farmers need to employ good Agricultural practices. One of such technology is Conservation farming. Conservation farming (CF), as applied in Zambia, involves a package of several key practices; dry-season land preparation using minimum tillage systems, pot holing, crop residues retention, seeding and input application in fixed planting stations and nitrogen-fixing crop rotations.

By definition, Conservation farming is any method of agriculture that aims to make the best use of natural resources in a good balance of the economic resources of the produce.

There are several variations around the world ranging from traditional approaches to modern mechanized approaches.

About 1995, following a couple of severe drought cycles in Zambia, the Conservation Farming Unit of Zambia and National Union of Zambia introduced the Zambian version of Conservation farming. This system was really developed along the lines of practice in Zimbabwe where a farmer was using “pot holes” or planting basins approach to revive a large commercial farm that the soil had been depleted and productivity low.

Conservation tillage is defined as a system or sequence of operations that reduces the loss of soil or water in comparison to losses incurred under conventional tillage systems, and it includes systems ranging from zero tillage and reduced tillage to different forms of crop residue

management (Kilmer, 1982). The term “conservation tillage” has many meanings in the literature, however, particularly when its definition includes the management of crop residues. For this reason, the analysis of tillage practices in certain cases requires a working definition of conventional tillage and conservation tillage, as well as pot holing and minimum tillage, which are two forms of conservation tillage.

With this background, the Zambian version of Conservation farming can be defined as a method of best use of available resources and time that help to achieve higher yields than what is currently obtained especially given low and erratic rainfall patterns. Conservation farming involves adopting a number of husbandly practices that together comprise a complete farming system.

Conservation tillage methods include no-till, strip-till, ridge-till and mulch-till. Each method requires different types of specialized or modified equipment and adaptations in management.

No-till and **strip-till** involve planting crops directly into residue that either hasn't been tilled at all (no-till) or has been tilled only in narrow strips with the rest of the field left untilled (strip-till). **Ridge-till** involves planting row crops on permanent ridges about 4-6 inches high. The previous crop's residue is cleared off ridge-tops into adjacent furrows to make way for the new crop being planted on ridges. Maintaining the ridges is essential and requires modified or specialized equipment. **Mulch-till** is any other reduced tillage system that leaves at least one third of the soil surface covered with crop residue.

This study concentrates only on strip tillage practices and the benefit that are realized from this technology. With erratic rainfall in the past, poor input distribution and expensive fertilizers; farmers have an option to turn to reduced tillage practices. If this technology is followed correctly, farmers could have the advantage of achieving the intended target such as yield maximization, while minimizing cost. Therefore, they could plant a larger area as they would not be moving or turning over the soil before they plant, this serves both money and time (Gibson, 2003).

Additionally, labour requirements are spread over several months rather than being done at once, as it is also suitable for women returning residues, soil and water loss, improving infiltration, surface temperature and in turn improve soil. This technology of farming also minimizes losses in drought years and improves food security.

1.2 Problem Statement

Despite the efforts and extension education provided by the agricultural extension workers and other concerned parties to the smallholder farmers to achieve high rates of adoption of conservation tillage technology, very few small scale farmers have responded to the practice. Out of 31,400 farmers in Choma district only 1,600 farmers practice strip tillage.

However, going by the studies conducted to compare the output between conservation farming and conventional farming, most find conservation farming method increases yield by 50 per cent or more and doubles that of conventional oxen cultivation (Haggblade *et al.*, 2003).

In addition, a lot of scholars have looked mostly at agronomic and economic benefits of strip tillage but very little has been carried out to look at factors affecting its adoption, level of use and factors affecting its utilization in Zambia especially by small scale farmers who are worst hit by the occurrence of unfavorable climatic conditions such as droughts, floods etc.

The major reasons for the low levels of adoption of this technology are not known in Choma district despite its several agronomic and economic benefits. It's against this back ground that this study attempts to mitigate the gap for the low adoption of this technology in Choma district of southern province.

1.3 Objectives

1.3.1 General Objective

The overall objective of this study is to determine the factors that affect adoption of strip tillage in Zambia.

1.3.2 Specific Objectives

To identify the social economic and institutional factors influencing adoption of strip tillage practices.

To determine the extent to which the factors identified influence adoption of strip tillage.

1.4 Significance of the Study

Awareness of these factors would facilitate the enhancement of development and transfer of appropriate technologies. This information can then be used to determine adoption rates of strip tillage practices. The determination of the factors affecting the adoption of striptillage practices would help the government and policy makers and other organizations involved in the promotion of conservation farming to come up with specific measures to improve the rate of adoption of the practice. This in turn, will improve the production of food in the erratic rainfall regions and hence improve the National food security.

1.5 Organization of the Report

This thesis opens with chapter one which highlights the background information about the subject. It covers the problem statement, objectives, rationale of the study and conceptual framework. Chapter two focuses on literature review in which the meaning, factors affecting adoption of Strip tillage and benefits and constraints of adoption are discussed. Chapter three looks at the methodology that was used for the study. It encompasses the research design, description of the data collection procedure, sampling design and data analysis. Chapter four

highlights the findings and interpretation of the findings of the study, while chapter five looks at conclusion and recommendations based on the findings of the study.

1.6 Conceptual Framework

A farmer's decision to adopt a technology is based on the assumption of maximization of utility. The farmers have to use their resources efficiently to maximize the net benefit. In the case of conservation tillage methods available, the farmer has to ensure that the added cost is equal to the marginal returns in all the possible tillage methods available. If there is a higher net gain in anyone of the technology, then it becomes advantageous to continue investing in that method until the marginal benefit is equal to marginal cost (Shapiro *et al.*, 1992). Farmers who have not been exposed to conservation tillage methods may not be in a position to make informed decisions concerning their agronomic and economic benefits. Therefore, extension services are required to disseminate innovations among the farmers, for them to make informed decisions. Daniel Benor et al reported that technology adoption depends not only on effective input supply, but also on the extent to which the farmers are taught to make the best use of the resources. This extension services have to be vibrant among the small scale farmers.

Empirical models that have been used to study adoption include probit, logit and tobit. Probit and logit models use a binary variable, that is, zero to represent non-adoption and one to represent adoption. However, Baidu forson (1999) points out a possible loss of information in the use of these models and proposes the use of a tobit model which accounts for a dependent variable that has zero limits. Farm households differ in size of land that is put under the use of conservation tillage practices. In a given area, some non-adoption will also occur hence the preference in using tobit as it uses both, data at the limit as well as those above the limit to estimate regressions.

Under Tobit model, the preference of the i^{th} farmer for conservation tillage, can be represented by the equation;

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad 5$$

Where

$$y_i^* = \beta x + \mu_i, \quad \mu_i \sim N(0, \hat{\sigma}^2)$$

Here $i = 1, 2, 3, 4, 5 \dots n$ and denotes the sample size surveyed. y_i Is the dependent variable and represents the cultivation area in, hectares, where conservation tillage has been used. X Is a vector of explanatory variables postulated to explain the variation in the area cultivated allocated to conservation tillage practices? β Is a vector of unknown coefficients or parameters to be estimated? μ_i Is the independent normally distributed error term assumed to be normal with zero mean and constant variance σ . In summaries the model shall be defined as shown;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \dots + \beta_9 X_9 + X_{10} + E$$

Where:

Y is the proportion of the cultivated area that is allocated to strip tillage.

X1 is the household head age

X2 is the household size

X3 is the house head level of education in years

X4 is the gender of the household head

X5 is number of years in farming (experience)

X6 is contact with extension workers

X7 is access to credit services

X8 is distance from the main road

X9 is farm size

X10 is off farm income

E is the error term

The total change in y_i associated with a change in the explanatory variable can be decomposed into the change in the probability of being above zero and the changes in the values of y , if it is above zero.

The relationship between the expected value of all observations, E_{y^*} , and the expected conditional value above the limit E_{y^*} is given by

$$E_{y^*} = F(z)E_{y^*} \quad (2)$$

Where $F(z)$ is the cumulative density normal distribution function and $Z = X\beta / \sigma$.

Consideration of the effect of the K^{th} variable of X , for example age, can be decomposed as follows,

$$\frac{\delta E_{y^*}}{\delta X_k} = F(z) \left(\frac{\delta E_{y^*}}{\delta X_k} \right) + E_{y^*} \left(\frac{\delta F(z)}{\delta X_k} \right) \quad (3)$$

Thus the total change in E_{y^*} is made up of two components; (1) the change in the expected value of Y for those observations above the limit of zero, weighted by the probability of being above the limit, and (2) the change in the probability of being above zero, weighted by the expected value of Y , if above zero.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter discusses the meaning and definition of the study. It then highlights the major benefits of conservation tillage, adoption constraints faced by the small scale farmers, impact and transfer of adoption and paths of technology adoption from past studies and the conceptual models used to explain the decision of farmers to adopt technologies.

2.2 Meaning and Definition of the Study

Conservation tillage, defined as any planting practice or tillage operation that leaves at least 30% of the soil surface covered with crop residues, this has long been recognized for its ability to reduce soil loss from water and wind erosion (Langdale *et al.*, 1992).

Reduced tillage is a conservation farming effort that uses special implements like rippers to disturb the soil only in areas where seed will be planted (Hankukuet *al.*, 2005).

Strip tillage is a conservation system that uses a minimum tillage. It combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till by disturbing only the portion of the soil that is to contain the seed row. This type of tillage is performed with special equipment and can require the farmer to make multiple trips, depending on the strip-till implement used, and field conditions. Each row that has been strip-tilled is usually about eight to ten inches wide. Another benefit of strip-tilling is that the farmer can apply chemicals and fertilizer at the same time as tillage.

Conservation farming represents a local variant of traditional minimum tillage technologies adopted in many parts of Africa. Similar hand hoe planting basin systems have emerged across much of the Sahel as well as Cameroon, Nigeria, Uganda, and Tanzania (Critchley *et al.*, 1994; Reij, 2001). Ox-drawn rippers have expanded recently in Tanzania, Kenya, Namibia, and Mozambique while early work with tractor-drawn minimum systems in Zimbabwe and South

Africa provided much of the inspiration for the recent transfer to ox and hand hoe cultivation systems (Oldrieva, 1980).

Even though local development and promotion efforts date back scarcely a decade, many local observers consider conservation farming an emerging success story in Zambia. Its promoters note that conservation farming holds the potential to restore soil fertility to land damaged by years of excessive plowing and heavy applications of chemical fertilizer and to improve on farm yields and incomes with moderate input use. In years of low or sporadic rainfall, conservation farming offers important water harvesting benefits as well. Its most prevalent planting basin explicitly caters for small scale hand hoe farmers without reliable access to draft power. Conservation farming thus aims to improve not only efficiency and sustained soil fertility but also equity.

Most of the soils in Africa, including Zambia have been depleted of their natural fertility (Sanchez, 2003). Excessive mining of the soils with no sufficient efforts to restore or maintain soil fertility on a sustainable basis has been the major contributing factor. Crop production on most of these soils may require heavy supplementation with organic fertilizers. These fertilizers are also in most cases unaffordable and even inaccessible to poor smallholder farmers. Even for large scale commercial farmers in Zambia who afford inorganic fertilizers, a recent study has revealed that yields are far below (4tonnes/ha) the optimum potential of 8tonnes/ha (Gwart Year Book 2003). Soil fertility factors are the major contributors to such trends. Excessive use of inorganic fertilizers also on the other hand lowers the soil PH. Additionally the problem of the general reduction in rainfall pattern over the years has had great depressing effects on crop production with the majority of households farming practices such as reduced tillage that integrate restoration and maintenance of soil fertility with soil and water conservation need to be investigated, integrated and promoted. The onus remains to the smallholder farmer to take up the technology as it will enable them to minimize crop loss in years of draught and improves food security.

2.3 Benefits of Conservation Tillage

Strip tillage has enormous potential to contribute to sustainable, low-cost food production on a global scale due to its multiple benefits. These benefits include: a reduction in soil, nutrients and fertilizer losses by water erosion; better use of soil water resources, lower energy costs for soil preparation and less manual labour; and improvements in wildlife habitats, soil fertility and productivity.

In most African and Latin American countries, conservation tillage techniques were first introduced to large-scale commercial farmers, and subsequently adjusted and disseminated to small-scale farmers who now use direct sowing with animal traction equipment.

Reduced tillage practices in agronomic crops such as corn, soybeans, and cotton, sorghum and cereal grains were introduced over 50 years to conserve soil and water. Crops grown without tillage use water efficiently, the water holding capacity of the soil increases, and water losses from the runoff and evaporation are reduced. For crops grown without irrigation in drought-prone soils, this more efficient water use can translate into higher yields. In addition, soil organic matter and population of beneficial insects are maintained, soil and nutrients are less likely to be lost from the field and less time and labour is required to prepare the field for planting.

In general, the greatest advantages of strip tillage are realized on soils prone to erosion and drought, but significant advantages were seen in a 12-year study of Wisconsin Silt-loans which were excellent Agricultural soil. This study found improvements of many soil quality factors compared to chisel and plow treatments. These included greater water-stability of surface soil aggregates, higher microbial activity and earthworm populations and higher total carbon. (File:\\A | Conservation Tillage.htm)

In Zambia, Ox-farmers can rip or prepare land using the Magoye ripper. Ripping is done in narrow bands or planting furrows at regular intervals from each other in dry season, the soil in between remains undisturbed. Since seeds are planted in the same place annually subsequent crops can easily take up residual fertilizer from previous cereal crops besides, deep-rooting crops

can be used in crop rotation to break hard pan by creating root channels that weaker root crops can trail after that hand hoes grows do not need any additional capital equipment, which can be required by other smallholder.

The onus remains on small scale farmers to take up the technology as it will enables them minimize crop loss in the year of droughts and improve food security (Gibson, 2003).

In Zambia, this technology has been targeted to small scale farmers who are usually incorporated into contract farming; this involves giving farmers loans that are in form of input that include: seed, fertilizers and extensional Education. Assessments of this technology has reported substantial increase in farmer yield, often double achievement of these substantial gains in output typically requires additional input, most particularly increased use of labour. The recent study has shown that labour is the most constraining factor that hinders voluntary adoption of the technology (Gibson, 2003).

2.4 Adoption Constraints faced by Small-scale Farmers

Despite all the positive research results and efforts of extension service, tillage is often misunderstood and done out of tradition, without reflecting newer technical options. This is particularly critical in tropical climates if tillage concepts from moderate regions are applied. Tillage also is the most time- and energy-consuming operation in arable farming and often creates labour or farm power (animal draught or motor) bottlenecks.

Hand tools (like hoes, forks, machetes, shovels and axes) are widely used in small-scale tropical farming areas. The hoe is used for tillage, harvesting or, with the axe, for bush clearing and in many parts of the tropics machetes are used for weeding. The most that can be prepared by hand per adult in any given season is about 0.5 ha.

The use of animal draught power greatly reduces the human labour requirement for crop production by the small-scale farmer. For example, ox ploughing in Kenya can increase the productivity of human labour up to 4 times (Mburathi, 1984). The mould board plough seems to be the only implement generally used with animal draught power for all tilling operations (land

preparation, ploughing, planting and weeding) in some of the tropical developing countries. Constraints to the use of the plough by farmers in semi-arid West Africa are the lack of time for this operation at the beginning of the cycle, given the shortness of the rainy season and the imperative need for early planting. Competition for time devoted to soil management, planting and weeding is particularly serious in the regions where rains start violently.

In Kenya, for example, few small-scale farmers own tractors and most farmers rely heavily on the services of private contractors. Private contractors in very few tropical countries only offer mechanized equipment for direct planting. However, the services provided for land preparation are sometimes unsatisfactory and often offer only one type of implement, i.e. the disc plough or the disc harrow, whereas sometimes other implements like chisel ploughs or cultivators would be more appropriate. The farmer is therefore forced to accept several ploughing operations with a disc plough to achieve an adequate seedbed, while the use of the proper implements at the right time might give a better seedbed at a lower cost (Mburathi, 1984) and with less soil damage. This is a situation found in many other developing countries in the tropics.

The transition from conventional to conservation-effective tillage practices requires more investment in management skills for some crops. If the machinery component has to be replaced or modified, adoption of conservation-effective tillage will be slower on small farms, in the tropics or elsewhere, where machinery is replaced less frequently. Usually equipment suitable for conservation tillage has a much higher purchase price than conventional equipment. That means that the capital investment for the transition to conservation farming is high. But, due to the higher work-capacity of the equipment, the actual operating costs are often lower than in conventional farming if farmers learn to share equipment and make the maximum use of it (Mburathi, 1984)

A successful conservation-effective tillage program, therefore, needs to be flexible enough to be adapted to a variety of economic, geographic, land-use and farmer-related variables by small-scale farmers in the tropics (Mburathi, 1984)

2.5 Impacts and Transfer of Adoption

Country extension services need to pay more attention to those tillage practices developed by the farmers themselves, which have been proved effective in soil and water conservation. But with the increasing average age of farmers as a result of the migration of youth to the urban areas, tillage practices as well as tillage equipment will need to be adjusted to these labour constraints, although this can only be achieved within the financial resources of the farmer. Furthermore, it has been found that some of the improved implements introduced to farmers for effective tillage have not been widely adopted, and it is necessary to ascertain the reasons for this (Benites *et al.*, 1997).

A lot of advantages have been realized in agricultural production with the conservation tillage concept, which has greatly increased production worldwide. For example, in Uganda, like in many countries in East and Southern Africa, conservation tillage practices have increased crop production especially in the dry-land areas through the increase of stored soil water and minimized labour, energy and capital requirements in agricultural production. However, despite the popular campaign for the adoption of conservation tillage practices in the region, the move has at times been hampered by several issues which include socio-economic and gender ones.

In the tropics, tillage research is limited and relatively few institutions undertake research and development. In many countries the links between research and extension services are weak or non-existent. Tillage systems developed in temperate regions have been introduced mainly through machinery agents or agricultural research station practices. There have been various degrees of short-term success on large-scale farms, but also failures in many instances where the soils were not adequately studied, resulting in degradation by erosion and compaction (Benites *et al.*, 1997).

Small-scale farming development needs to receive special attention if agricultural practices are to be changed and more sustainable techniques are to be adopted. The system or systems introduced must fit into the small-scale farmer's production pattern and cropping system and show the clear benefits available to the farmer at acceptable cost/benefit relations. Adequate knowledge of the

soils, climate and cropping systems is indispensable for the development and choice of appropriate tillage systems. One of the promising approaches to such informal technological exchange is through networking. This could provide inspiration while the actual conservation tillage system will have to be developed site - specifically with the local farmers (Benites *et al.*, 1997).

2.6. Paths of Technology Adoption

The earlier studies emphasized the importance of farm size and credit constraints on the adoption process (Feder, 1980; Feder, Just, and Zilberman, 1985; Sunding and Zilberman, 1984). Some of the recent literatures have focused on the capacity of farmers to make decisions, learn the technology and the role of learning in the diffusion process (Foster and Rosenzweig, 1995a; Cameron, 1999; Conley and Udry, 2003). Cameron (1999) work on rural Indian village emphasized the importance of learning-by-doing or-using. Conley and Udry (2003) examined the role of social learning for technology adoption by farmers in Ghana.

Economic investigations have typically made assumptions that relate observed relationships between individuals (such as geographical proximity) and unobserved but plausible inter-farm flows of information. This set of assumptions underlies all attempts to identify effects, which is clearly limited by available data.

There are several factors that could contribute to the observed pattern of geographical adoption of a new technology rather than just social learning. In the absence of data on direct learning effects, we assume that pressure from social emulation and localized competition encourages farmers to adopt new and profitable technologies. Baptistia and Swan (1998) demonstrated the geographical concentration of rivals encouraged competition and stimulated innovative activity, possibly leading to new entrants and firm growth.

CHAPTER THREE

METHODS AND PROCEDURES

3.1 Introduction

This chapter outlines the methods and procedures used to achieve the stated goals. It gives information on the area of study, research design, sampling procedure, data collection and data analysis tools that were used in the study.

3.2 Study Sites

The sample survey was undertaken in Choma district of Southern province. It covered six agricultural camps, namely Mbabala, Macha, Mapanza, Simaubi, Mpinda, and Kasiwe. The sample consisted of smallholder farmers from villages only. Choma district was chosen because it is located in ecological zone 1, which receives erratic rainfall supply in the country. And such technology under study was designed for such regions.

3.3 Data Collection Methods

A sample of 81 households was randomly selected from the camps to include representative samples of areas with extension intervention and without extension intervention. This was able to capture adopters and non-adopters in project areas and outside the project areas. Both primary and secondary data was collected in this study. Primary data was collected by means of structured questionnaires administered as interviews. Secondary data was collected from various institutions such as the Ministry of Agriculture and Cooperatives, Conservation farming unit and CSO, and from relevant publications.

3.4 Data Analysis

The field data was analyzed in SPSS to produce descriptive statistics and the output was organized using EXCEL. The data was tested using the Breusch-Pagan Godfrey test for potential heteroskedasticity which may be present across households due to the use of cross sectional data. Heteroskedasticity was significant at 5% level. The computed chi square value was “31.48” which is higher than the critical value of “15.51”. This was corrected for by running EGLS on the initial regression. This resulted in high multicollinearity in some of the variables. A Tobit model corrected for Heteroskedasticity was run in STATA.

Under Tobit model, the preference of the i^{th} farmer for strip tillage, y , can be represented by the equation;

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{otherwise,} \end{cases}$$

Where;

$$y_i^* = \beta x + \mu_i, \text{ and}$$

y_i = total area cultivated using strip tillage for farmer i

β = vector of parameters to be estimated

μ_i = standard error term

x = vector of independent variables to be included in the model. The variables specified were, household size, Farm size, farming experience, distance of the farm from the main road, age of household head, access to technical advice, credit services and dummy variables include; household head sex, no education, primary, secondary, trade certificate.

3.5 Limitations of the Study

In this research, a sample size of 100 small scale farmers was supposed to be sampled. Covering all sampled farmers was not possible because of the resources to do that were limited. Secondly, the gathering of information from some farmers was difficult using structured questionnaires because of illiteracy. This affected the interviewing process with farmers especially among households with no common language with the researcher. In such cases, an interpreter was used and this meant more time for data collection. The other problem was that of poor record keeping by the farmers, especially those for the quantities of inputs (e.g. fertilizer, seeds), cost of inputs and yields. This, therefore, resulted in the researcher using estimates.

CHAPTER FOUR

STUDY FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the study findings. It begins with a presentation and discussion of the Demographics characteristics of the respondents. It goes on to present the Tobit regression estimates with a discussion of the resulting outputs.

4.2 Demographic Characteristics of the Sample

Adoption by farmers is grouped into non-adopters and adopters. This is done to allow for comparisons of means of the characteristics across the two adoption levels. In this context, adopters are said to occur where farmers have applied their cultivated area to strip tillage. The non-adopters on the other hand, are those households that did not use strip tillage on any part of their cultivated land.

The table below reveals that there were 57 adopters in the sample representing approximately 70.4 percent and 24 non adopters also representing 29.6 percent. The table as well as the bar chart clearly highlights this as shown below.

Table 1: Distribution of farmers by category

Adopter Category	Numbers	Percent
Adopters	57	70.4
Non Adopters	24	29.6
Total	81	100

Gender Distribution

From the table below, majority of the farmers (42 and 19) were males while (15 and 5) were females representing adopters and non-adopters respectively. There are more males because only the household head in each household was the respondent implying that females were respondents only in female headed households. Therefore, there were more male headed households than female headed households.

Table 2: Distribution of Farmers by Sex

Adopter Category	Sex of Respondent: Numbers		Sex of Respondent: Percent	
	Male	Female	Male	Female
Adopters	42	15	68.9	75
Non Adopters	19	5	31.1	25
Total	61	20	100	100

Distribution of Farmers by Age

The majorities of the farmers out of the total count of 57 adopters were 19 and this fall within 41 to 50 years age category, this is followed by 31 to 40 years age category with the least in the 20 to 30 years category. About 8 comprised the 31 to 40 years category, 6 the 61 to 80 with the least count of 2 in the 20 to 30 years categories for the non-adopters' group category. On average the non-adopters group comprised mostly the aged. This implies that the majority of the farmers who adopted the technology practice (strip tillage) are in the highly productive age groups. This is shown in a table below.

Figure 2: Distribution of Farmers by Age

Adopter Category	House Hold Age (Numbers)				
	20-30	31-40	41-50	51-60	61-80
Adopters	9	16	19	13	0
Non Adopters	2	8	5	3	6
Total	11	24	24	16	6

Education Levels

The Majority of the farmers (adopters) 33 (40.8%) and 23 (28.4) attended primary and secondary schools respectively, only 1 (1.2%) had a trade certificate. At least 14 (17.3%) attended primary school, 1 (1.2%) attended secondary school, 9 (11.1%) had not attended any school at all. Thus, the majority of the farmers had little or no formal education implying that their level of comprehension to new technologies and improved farming practices could be low. This is illustrated in the table below.

Table 4: Distribution of Farmers by Education Levels

Adopter Category	Education level: Numbers				Education level: Percent			
	No Education	Primary	Secondary	Tertiary	No Education	Primary	Secondary	Tertiary
Adopters	0	33	23	1	0	40.8	28.4	1.2
Non Adopters	9	14	1	0	11.1	17.3	1.2	0
Total	9	47	24	1	11.1	58.1	29.6	1.2

Distribution of Farmers by Marital status

On the marital status of the respondents, the research revealed that majority of the respondents (adopters and non-adopters) was married. There were 50 adopters and 14 non adopters who were married and this represent percentages of 78.1% and 21.9% within the category respectively. Further, 4 respondents from each group belonged to a category of the widow and this represents a percentage of 50% and only 2 adopters and 3 non adopters were single and this represents 40% and 60% within the category respectively, and 1 adopter and 2 non adopters of the respondents were divorced representing 33.3% and 66.7%. Details of these findings are shown in the table below.

Figure 3: Distribution of Farmers by Marital Status

Adopter Category	House Hold Size Marital Status							
	Married		Single		Widow		Divorced	
	Numbers	Percent	Numbers	Percent	Numbers	Percent	Numbers	Percent
Adopters	50	78.1	2	40	4	50	1	33.3
Non Adopters	14	21.9	3	60	4	50	2	66.7

Family Size

Respondents were also asked about their family size, and the research revealed that among the adopters 27 respondents had the family size ranging from 4-6 households, 20 had 7-11 households representing 77.1% and 71.4% within each category respectively, while 6 respondents had the family size ranging from 1-3 people representing 54.5%, and 4 respondents had family size of 12 households and above representing 57.1%. On the other hand among the 24 non adopters, 8 had 4-6 and another 8 had 7-11 household members representing 32.9% and 28.6% within each category respectively. 5 had 1-3 and the other 3 had 12-above family size. As shown in the table below.

Table 6: Distribution of Farmers by Family size

Adopter Category	House Hold Size (Numbers)			
	1-3	4-6	7-11	12- Above
Adopters	6	27	20	4
Non Adopters	5	8	8	3
Total	11	35	28	7

Hectares Cultivated by Farmers

The majority (62.5%) of the non-adopter farmers cultivated between 3-4 hectares of land, only 29.5% cultivated above 5 hectares while 8.3% of the farmers cultivated between 1-2 hectares and none less than one hectare. For the adopters, the survey shows that 45.6% farmers cultivated above 5 hectares this is followed by 35.1% who cultivated between 3-4 hectares and only 19.3% of the farmers cultivated between 1-2 hectares. This implies that, the adopter subgroup has the highest expandable area when total farm size is compared with the total cultivated area. As shown below;

Table 7: Distribution of Hectares Cultivated by Farmers

Hectare Cultivated	Non Adopters		Adopters	
	Numbers	Percent	Numbers	Percent
Less than 1 ha	0	0	0	0
1-2 ha	2	8.3	11	19.3
3-4	15	62.5	20	35.1
5-above	7	29.2	26	45.6
Total	24	100	57	100

In order to understand the variations of these characteristics across the different adoption levels, there is need to test the significance of these differences using regression analysis.

4.3. Regression Model Results

This section considers the results that were obtained after running the Tobit model in STATA. The results obtained from running the model were used to determine if farmers had adopted strip tillage practice and the significance of the various socio-economic factors that have been postulated to affect farmers' extent of adoption.

4.4 The Tobit Regression Model

The Table below presents the Tobit regression parameters. The dependent variable is the area allocated to strip tillage. The model had a log likelihood of -68.528 and was done for 81 observations of which 24 were censored at value equal to zero for the farmers that do not allocate any land to strip tillage while 57 were uncensored.

Table 8: Parameter Estimates from Tobit Regression: (Dependent Variable: Area Allocated to Strip Tillage)

Independent Variables	Coefficient	Marginal effects	Elasticity	Standard error	t	P> t
House hold Size	0.134598	0.05309	0.0243621	0.0530945	0.25	0.801
House hold Sex	-0.0670858	-0.12775	-0.0575509	0.1277535	-0.53	0.601
House hold Age	-0.1276358	-0.07564	-0.0364879	0.1967381	-1.66	0.036*
Marital Status	-0.1131165	-0.08749	-0.246875	0.0874887	-1.29	0.200
Average Distance	-0.0158598	-0.04404	-0.0311273	0.044044	-0.36	0.720
Education Level	0.3341438	0.06367	0.4557339	0.0636718	-5.25	0.000*
Access to Credit	-0.3773918	-0.04013	-0.0527386	0.1291211	-2.92	0.005*
Technical Advice	0.3169538	0.12912	0.0586313	0.129371	2.45	0.017*
Income	-0.596377	0.12937	0.2869763	0.0401277	-1.49	0.142
Farm size	0.6346847	0.15526	0.5477763	0.0365545	5.49	0.015*

5% Level of significant

From the table above, it can be said that the adoption of strip tillage is significantly explained by farm size (p-value=0.015), education level (p-value=0.000), and age of house hold (p-value=0.036), technical advice (p-value=0.017), and credit access (p-value=0.005).

The coefficients of those factors which are either negative or positive indicate the direction of the change in the dependent variable as a result of the change in the particular independent variable while the marginal effects indicate the amount of change in the dependent variable due the change in a particular independent variable holding other factors constant. While elasticity indicate the percentage change in the dependent variable due to a one percent change in a particular independent variable holding other factors constant.

Therefore, holding other factors constant, a one percent increase in the age of a household would reduce the farmer's decision to allocate land to strip tillage by 3.6 percent, implying that aged farmers become more conservative and less acceptable of new ideas. The positive sign in the marginal effect for education level shows that a 1year increase in a household's level of education will increase area allocated to strip tillage. From the elasticity of 0.4557339, it can be said that a 1% increase in the level of education will result in a 45% increase in the farmers' decision to allocate land to strip tillage. Indicating that education enhances the allocative ability of decision makers by enabling them to think critically and use information sources efficiently. Farmers with more education should be aware of more sources of information, and are efficient in evaluating and interpreting information about innovations than those with less education. It was also found that a one percent increase in farmer's access to credit would reduce extent use of strip tillage by 5.27 percent this means that farmers may be very cautious to new innovations due to uncertainty and the risks associated (failure to meet financial obligations).

On the other hand, it was found that a one percent increase in the access to extension services on strip tillage practices would result in an increase in farmer's decision to allocate more land to strip tillage by 5.86 percent. . This is because of the informative role it plays in the activities of the farmers. Similarly, a one percent increase in the farm size would increase farmer's adoption of strip tillage by 54.7 percent, implying that, farmers with big farm sizes are more likes to try out new innovations as compared to those with less. It is also worth to note that some of the socio-economic factors like family size, sex, household head marital status, off farm income and distance from the main road were not statistically important in explaining the adoption of strip tillage at 95% C.I

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusion and recommendations of the study based on the findings and interpretations of the study.

5.2 Conclusions

The new technology of conservation farming in particular strip tillage is essential to improving the food security of smallholder farmers as well as providing a sustainable way of earning income. This technology allows constrained smallholder farmers to benefit from the advantages of using this technology.

This study was designed to determine the factors affecting households' decisions to adopt strip tillage. Tobit analysis was employed to analyze and discuss the individual factors hypothesized to affect the adoption of the technology. The factors studied included household size, sex of the household head, level of education, marital status, off farm income, farm size, distance from the main road, access to credits and access to technical services, age of the household head and livestock ownership. The factors which were identified as being statistically significant were age of the farmer, education level, farm size, access to credits and access to technical services. The significance of each of these variables was discussed to reveal its impact on adoption decisions.

5.3 Recommendations

Researchers should continue to develop technologies that could be adopted by farmers for the purpose of high productivity gains. In addition, efforts should be made by scientists to design institutional arrangements that will facilitate technology to flow up to the farmers. The government should employ enough agricultural extension officers so that they can adequately provide technical assistance necessary for adoption of a new technology.

The study highlighted that education was important in explaining adoption of strip tillage. Thus, farmers with a considerably higher access to education had a higher likelihood of effectively accessing and utilizing information and knowledge of improved agricultural practices. It is thus recommended that government facilitates an easy access to education particularly for the younger generation in order to reduce high illiteracy level associated with most smallholder farmers.

A suggestion to future studies is to carry out surveys across the country with a much larger sample size in order to increase variations within the sample hence, capture more variables of importance. When results of such a survey are analyzed with available literature on the characteristics of the conservation tillage technologies, there will be a greater understanding for the adoption of innovative technologies in the country.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

Questionnaire serial number:

Factors Affecting the Adoption of Conservation (strip) Tillage in Zambia's Choma District

Department of Agricultural Economics and Extension Studies
The University of Zambia - Lusaka

This questionnaire is for academic purpose only. Be rest assured that all the information you provide will be treated as private and confidential as possible. Feel free to answer all the questions honestly. Your cooperation in this regard will be highly appreciated.

Instructions: Please tick in the boxes provided and write in the blank spaces provided.

(A)GENERAL INFORMATION

1. Name of the village/ farm _____		
2. Name of the farmer _____		
3. Age of the farmer _____		<input style="width: 40px; height: 15px;" type="text"/>
4. Marital status		
1. Single	<input style="width: 40px; height: 15px;" type="checkbox"/>	
2. Married	<input style="width: 40px; height: 15px;" type="checkbox"/>	
3. Divorced	<input style="width: 40px; height: 15px;" type="checkbox"/>	<input style="width: 40px; height: 15px;" type="checkbox"/>
4. Widow	<input style="width: 40px; height: 15px;" type="checkbox"/>	
5. Widower	<input style="width: 40px; height: 15px;" type="checkbox"/>	
6. Separated	<input style="width: 40px; height: 15px;" type="checkbox"/>	
5. Gender of the household head		
1. Male	<input style="width: 40px; height: 15px;" type="checkbox"/>	
2. Female	<input style="width: 40px; height: 15px;" type="checkbox"/>	
6. Number of own children _____		<input style="width: 40px; height: 15px;" type="text"/>
7. Number of dependants in the household	<input style="width: 40px; height: 15px;" type="checkbox"/>	<input style="width: 40px; height: 15px;" type="text"/>
8. Number of adults in the household	<input style="width: 40px; height: 15px;" type="checkbox"/>	<input style="width: 40px; height: 15px;" type="text"/>
9. What is your level of education?		
1. Primary	<input style="width: 40px; height: 15px;" type="checkbox"/>	
2. Secondary	<input style="width: 40px; height: 15px;" type="checkbox"/>	
3. Tertiary	<input style="width: 40px; height: 15px;" type="checkbox"/>	
4. Not attended school	<input style="width: 40px; height: 15px;" type="checkbox"/>	

(B) AGRICULTURE AND EXTENT OF PRODUCTION

10. For how long have you been farming? _____
11. How much land do you own/rent?
1. Owned land _____ Ha
2. Rented land _____ Ha
12. Have you ever heard about strip tillage?
1. Yes
2. No
13. If yes to question 12, from who?
1. Government
2. Friends
3. Village meetings
4. Radio or TV
5. Publications
6. Other, specify
14. When did you start practicing strip tillage? _____
15. What size of your farm do you cultivate _____ (ha)
16. How much of it is under strip tillage _____ (ha)
17. And how much of it is under conventional tillage _____ (ha)
18. Do you receive training in strip tillage?
1. Yes
2. No
19. If yes to question 18, who trained you?
1. Government
2. NGOs
3. Friends
4. Others specify
20. Do you have an access to?
- | | Yes | No |
|---------------------------------|-----|-----|
| 1. Technical assistance | [] | [] |
| 2. Credit services | [] | [] |
| 3. Incentives in form of inputs | [] | [] |
21. If yes, from who and how often? Specify _____
22. What is your main source of your inputs?
1. Own
2. NGOs
3. Cooperatives
4. Government
5. Other, specify _____

23. How do you obtain your inputs?
- 1. Buying in cash
 - 2. Use of credits
 - 3. Given free
24. If you used credits, where did you obtain it? _____
25. If you did not use a credit, would you want to have access to it next season?
- 1. Yes
 - 2. No
26. Do you have access to information about organizations offering agricultural credits?
- 1. Yes
 - 2. No
27. How much do you spend on (kwacha?)
- 1. Seed _____
 - 2. Fertilizer _____
 - 3. Chemicals _____
28. How much money do you spend as a household on farming?
- 1. per month _____ (kwacha)
 - 2. per annual _____ (kwacha)
29. Do you hire any labor?
- 1. Yes
 - 2. No
30. If yes to question 29, what form of payment (money or material)? _____
31. How far is your farm from the main road? _____ (km)

(C) SOCIAL ECONOMIC INDICATORS

32. What type of roof is your house made of?
- 1. Thatch (Grass)
 - 2. Asbestos
 - 3. Iron sheets
33. What is your house made of?
- 1. Mud bricks
 - 2. Concrete blocks
 - 3. Others (specify) _____
34. What animals do you have?
- 1. Chicken
 - 2. Cattle
 - 3. Goats
35. How many animals mentioned in Q.34 do you have?
- 1. Chicken
 - 2. Cattle
 - 3. Goats

36. Are you engaged in other off farm activities?

1. Yes

2. No

--

37. If your response to Q.36 is yes, mention them? _____

38. If your response to Q.36 is yes, how much income do you get from? _____