# ASSESSMENT OF FACTORS AFFECTING THE ADOPTION OF MINIMUM TILLAGE PRACTICES IN SINAZONGWE DISTRICT.

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

**BY**

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## LIST OF ABBREVIATIONS.

| | |
|---|---|
| **CA** | Conservation Agriculture |
| **CF** | Conservation Farming. |
| **CFU** | Conservation Farming Unit |
| **DACO** | District Agriculture Coordinator |
| **FAO** | Food Agriculture Organization |
| **FSP** | Fertilizer Support Program |
| **GART** | Golden Valley Agricultural Research Trust |
| **MACO** | Ministry of Agriculture and Cooperatives |
| **NGO** | Non Governmental Organization |
| **RELACO** | Research in Latin American Conservation Farming Network. |
| **SPSS** | Statistical Package for Social Sciences |
| **USA** | United State of America |

## ABSTRACT

**Assessment of Factors affecting the Adoption of Minimum Tillage Practices in Sinazongwe District.**

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The main objective of this study was to assess the factors that affect the adoption of minimum tillage practices in Sinazongwe District in Southern Province of Zambia. The study was based on sample survey data from the District. A Tobit analysis was used to identify the factors that motivate the level and intensity of adoption of Minimum tillage practices in the district. The article considers explanatory variables like the level of education of the household head, the household size, age of the household head, the sex of the household head, the marital status of the household head, total value of assets, farm size, dependence ratio, total area cultivated in ha, distance to the main road, access to credits, access to incentives, access to technical advice and livestock ownership.

The results showed that adoption of Minimum tillage in the District is explained by farm size, household size, the age of the farmer, level of education of the household head and livestock ownership. The findings revealed that a household's decision to adopt Minimum tillage is significantly responsive to farm size (p-value = 0.017), household size, (p-value = 0.005), the age of the farmer (p-value = 0.036), level of education of the household head (p-value = 0.054), and livestock ownership (p-value = 0.013). These are the factors that the extension agents ought to consider as they diffuse the information about the adoption of this technology.

Minimum tillage is an essential technology to improving the food security of smallholder farmers as well as providing a sustainable way of earning income. Extension education should emphasize the importance of the technology by explaining its several agronomic and economic benefits to the farmers. The government should introduce simple implements such as Magoye ripper at a reasonable cost so that farmers with smaller household sizes can use them. This would increase the adoption rates of the technology for it is labour intensive.

# CHAPTER ONE
# INTRODUCTION

## 1.1 Introduction and Background

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. He in turn had picked this knowledge from Texas USA and the Texans had picked it up from Sahel Africa. Africa in the desert and dry land zones had been using holes in the ground as a water conservation method for many years. Perhaps they did not maintain permanent planting holes as are seen in the modern version, but they did not disturb much of the land either.

The introduction of Conservation farming in Zambia has positive effect in many places. It has started to change the thinking about agriculture as a seasonal rather than a year round operation. 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). 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 (Gibson, 2003).

This study concentrates only in Minimum 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 Minimum tillage practices. If this technology is followed correctly, farmers could have the advantage of achieving the intended target such as yield maximization, while minimizing costs. 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 farmers to achieve high rates of adoption of Minimum tillage technology, very few small scale farmers have responded to the practice. Going by the studies conducted to compare the output between conservation farming and conventional farming, most find substantially higher yields on conservation farming, often double those achieved under conventional tillage (Haggblade and Tembo, 2003).

The major reasons for the low levels of adoption of this technology are not known in Sinazongwe District despite its several agronomic and economic benefits. It's against this back ground that this study attempted to find out the reasons for the low adoption of this technology in Sinazongwe District in the Southern Province of Zambia.

## 1.3 Study Objectives

1. To find out the farmers' perceptions and feelings about Minimum tillage practices in the district.
2. To determine the factors affecting adoption of Minimum tillage in the district.
3. To determine the extent to which the factors identified influence adoption of Minimum tillage

## 1.4 Study Significance

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 adoption of Minimum tillage practices. The determination of the factors affecting the adoption of Minimum tillage practices would help the government and policy makers 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 low rainfall regions and hence improve the National food security.

## 1.5 Conceptual Framework

Factors affecting adoption of Minimum tillage can be divided into three major categories; farm and farmer's associated attributes; attributes associated with technology. Factors in the first category include farmer's education, age, family size and farm size. The second category depends on the type of technology. The third category assesses how different strategies used by farmers (e.g. commercial verses subsistence farmers) influence adoption. In this study a Tobit model will be used to test factors affecting the adoption of Minimum tillage. The Tobit model accounts for a continuous dependent variable that has a zero limit that is characterized by a non-zero probability mass. This description fits well with factors affecting the adoption of Minimum tillage if the latter is defined as the proportion of total cultivated area using Minimum tillage. This is so because there are typically a large proportion of the smallholder farmers that are not using Minimum tillage at all. The Tobit model (Mc Donald and Moffat; Maddala 1983), which test factors affecting the incidence and intensity of adoption, can be specified as below.

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 limit. Farm households differ in size of land that is put under the use of minimum 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 Minimum 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*

$$y_i^* = \beta X + \mu_i \qquad \mu_i \neg N(0, \hat{\sigma}^2)$$

Here i= 1, 2, 3, 4, 5...n and denotes the sample size surveyed. $y_i$ is the dependent variable and represents the cultivated area in, hectares, where Minimum tillage has been used. $X$ is a vector of independent variables. $\beta$ is a vector of unknown coefficients or parameters to be estimated. $\mu_i$ is the independent normally distributed error term assumed to be normal with zero mean and constant variance $\sigma$.

### 1.6 Structure of the Report

This research report is divided into five (5) chapters and is laid out as follows. After presenting the introduction and background, statement of the problem, study objectives, study significance and conceptual framework in chapter one, chapter two presents a discussion on the literature review; chapter three presents the research methodology. Study findings are discussed in chapter four and the Report ends with chapter five which contains the conclusions and recommendations.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews relevant literature on definitions and the scope of the study, agronomic and economic benefits of minimum tillage, and constraints to adoption of the technology by small-scale farmers, technology transfer and adoption impacts from previous studies.

## 2.2 Definitions and the Scope 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, has long been recognized for its ability to reduce soil loss from water and wind erosion. Minimum tillage is a conservation farming effort that uses special implements like rippers to disturb the soil only in areas where seed will be planted (Hankuku, 2005).

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. 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, IMAG 2001).

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. 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 (4 tonnes/ha) the optimum potential of 8tonnes/ha (GART 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 minimum 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 Agronomic and Economic Benefits of Minimum Tillage

Conservation 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 minimum 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. This included greater water-stability of surface soil aggregates, higher microbial activity and earthworm populations and higher total carbon 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 porn 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 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 Constraints to Adoption of the Technology 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 mouldboard 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 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 Technology Transfer and Adoption Impacts**

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 and Ofori, 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 and Ofori, 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 and Ofori, 1997).

# CHAPTER THREE
# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter outlines the methods and procedures used to achieve the stated objectives. It gives information on the study sites, data collection and data analysis tools that where used in the study.

## 3.2 Study Sites

The sample survey was undertaken in Sinazongwe District of Southern Province. It covered eight Agricultural Camps namely: Muziyo, Nkandabbwe, Sinazeze, Sinazonwe, Mwananzoke, Kanchindu, Muchekwa, and Maamba. The sample consisted of smallholder farmers from villages only. Sinazongwe 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 74 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. 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 and NGOs such as World Vision, DUNNAVANT and CFU, 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 of 41.48 which is higher than the critical value of 19.67. This was corrected for by running EGLS on the initial regression. This resulted in high multicollinearity in some of the variables such as could be seen from the high VIF. This was corrected for by dropping the variables with abnormal VIF. A Tobit model corrected for Heteroskedasticity was run in STATA.

Under Tobit model, the preference of the i th farmer for Minimum 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;

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

$y_i$ = total area cultivated using Minimum tillage for farmer i

$\beta$ = vector of parameters to be estimated

$\mu_i$ = standard error term

$x$ = vector of independent variables to be included in the model. The variables specified were: household head, education level of the household head , household size, Farm size, total area cultivated, dependence ratio, distance of the farm to the main road, age of household head, livestock ownership and dummy variables include; household head sex, married, and access to technical advice on Minimum tillage.

# CHAPTER FOUR
# STUDY FINDINGS AND DISCUSSION

## 4.1 Introduction

This chapter presents and discusses the study findings. It begins with discussion of the Demographic characteristics of the respondents and the presentation of the perception of the farmers about Minimum tillage. It goes on to present the OLS and Tobit regression estimates with a discussion of the resulting outputs.

## 4.2 Demographic Characteristics of the Sample

Adoption by farms is grouped into non-adoption, partial adoption and complete adoption. This is done to allow for comparisons of means of the characteristics across the three adoption levels. In this context, complete adoption is said to occur were farmers have applied their total cultivated area to Minimum tillage. The partial adoption households that used Minimum tillage on part of their cultivated area. Non adoption represents the households that did not use Minimum tillage on any part of their cultivated land. From the sample of 74 farmers, 5.4% had used Minimum tillage on their entire cultivated area while 51.4% had only used Minimum tillage on a fraction of the total farm size and the remaining 43.2% did not use any form of Minimum tillage.

**Table 1 Demographic Characteristics of the Sample.**

| Characteristics | Non-Adopters | Partial Adopters | Complete Adopters |
|---|---|---|---|
| **Type of Household** | | | |
| Male headed (%) | 46.25 | 55 | 75 |
| Female headed divorced (%) | 3.75 | 6.0 | 0 |
| Female headed widowed (%) | 12.5 | 2.5 | 0 |
| Singles (%) | 37.5 | 36.5 | 25 |
| Average Age of Household head (years) | 52.23 | 48.47 | 45.8 |
| **Level of Education** | | | |
| Primary Education (%) | 78.5 | 72.5 | 75 |
| Secondary Education (%) | 20 | 27.5 | 25 |
| Tertiary Education (%) | 1.5 | 0 | 0 |
| **Mean of Variables** | | | |
| Total Cultivated Area (Ha) | 1.57 | 2.97 | 2.77 |
| Distance (Km) | 3.45 | 2.56 | 0.53 |
| Farm Size (Ha) | 2.53 | 3.42 | 3.89 |
| Livestock Ownership | 24.5 | 10.72 | 6.85 |
| Access Technical Advice (%) | 71.42 | 90.4 | 75 |
| Household Size | 6 | 9.3 | 9 |
| Access to Credits (%) | 32 | 43 | 35 |
| Dependence Ratio | 0.65 | 1.32 | 1.23 |

Source: Own Survey (2007)

There was no major variation in the average household size of partial and full adopters. The average household size was, however, lower in the non adopters. Households which have completely adopted the use of Minimum tillage on their cultivated areas had the highest proportion of male household heads when compared with proportions in the partial and non adoption samples. Differences could be noted in the average age of the household head across the adoption levels with the oldest average belonging to the non adopters, a trend which can also be seen in the distribution of average household age across the adoption levels. In terms of education, it can be noted that majority of non adopters only attended primary school. The complete adopter subgroup has the highest expandable area when total farm size is compared with the total cultivated area.

Access to credit services is generally low in all the subgroup while partial adopters have the highest proportion of its sub sample having received technical advice. Regarding to livestock ownership, non-partial adopters have the highest number of livestock. 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 The Perception of the Farmers about Minimum Tillage

Out of the 74 respondents sampled, 96% had heard about Minimum tillage. About 57% of the respondents admitted that Minimum tillage has both agronomic and economic benefits. Out of this percentage, 31% benefit from higher yields, 14% like the technology because it improves soil structure, 8% said it reduces hunger and 2.7% said it requires less labour. Out of the total number interviewed 43% said that the technology has no benefits at all.

### 4.4 Regression Model Results

The EGLS was done for a total of 74 observations from the sample survey. The overall model was highly significant at 0.05 as it was indicated by the p-value of 0.000. The model's goodness of fit was found to be 0.654 meaning that about 65.4% of variations in the dependent variable are explained by the hypothesized independent variables.

**Table 2 Parameter Estimates of the EGLS Regression (Dependent Variable: Proportional Area cultivated using Minimum Tillage)**

| Variables | Coefficients | Standard Error | P – VALUE | ey/ex (elasticity's) |
|---|---|---|---|---|
| Intercept | 1.0459 | 1.20573 | | |
| Household Size | 0.41033** | 0.267313 | 0.005 | 0.5317 |
| Sex of Household Head | 0.063 | 1.20E-02 | 0.264 | -0.27593 |
| Age of Household Head | -0.1276** | 0.19674672 | 0.036 | -0.036587 |
| Education of the Household Head | -0.18756* | 0.18677 | 0.054 | -0.436878 |
| Married Male Head | 0.24576 | 0.3576874 | 0.196 | 0.211466 |
| Dependency Ratio | 0.23 | 0.65489 | 0.375 | 0.07583 |
| Total Cultivated Area in Ha | 0.091 | 0.0559384 | 0.273 | 0.43657 |
| Farm Size | 0.63468** | 0.036558 | 0.017 | 0.54772 |
| Distance | -0.446677 | 0.56773 | 0.207 | -0.687946 |
| Access to Technical Advice | 0.165731 | 0.85499 | 0.065 | 0.7876 |
| Livestock Ownership | -0.46577** | 0.3555 | 0.013 | -0.43393 |

**Source: Own Survey (2007).**

**Note:** Significance level: *= at 10%, **= 5%

Table 2 presents the analysis of variance and parameter estimates of the EGLS model. From the results, it can be said that area cultivated under Minimum tillage is dependent on household size, age of the farmer, total farm size, and livestock ownership. These are statistically significant at 95% confidence level. Education level of the household head is statistically significant at 90% confidence level. However, area cultivated under Minimum tillage is not significantly dependent on sex of the household head, marital status of the head; number of family members who supplied farm labor, access to technical advice, distance to the main road, and dependence ratio .

The role of education in technology adoption has been extensively discussed in the literature. 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 more efficient in evaluating and interpreting information about

innovations than those with less education. Education was found to positively affect adoption of new technology.

On the other hand, age of the household head is an important factor affecting adoption of agricultural technologies. The convention approach to adoption study considers age to be negatively related to adoption based on the assumption that with age farmers become more conservative and less acceptable of new ideas. On the other hand, it is also argued that with age farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to use new technologies more efficiently.

The effect of family size on adoption can be ambiguous. It can hinder the adoption of technologies in areas where farmers are very poor like Sinazongwe District and the financial resources are used for other family commitments with little left for purchase of farm inputs and implements necessary for the new technology. On the other hand, it can also be an incentive for adoption of new technologies as more agricultural output is required to meet the family food consumption needs or as more family labor is required for adoption of labor intensive technologies as it is the case with minimum tillage during weeding periods.

The coefficient of -0.46577 of Livestock ownership indicates that the more the number of animals the farmer has the less the adoption of Minimum tillage. This relationship is however only true to a certain level of increase in number of animals beyond which the farmers may opt for higher levels of mechanization such as tractor use. The total farm size is also significant to adoption of Minimum tillage. The coefficient of 0.63468 indicates that a 1hectare increase in farm size may result in about 0.63468 hectares increase in area under Minimum tillage. However at larger farm sizes, this relationship may not hold as farmers are more likely to use Conventional tillage using tractors on large farms than Minimum tillage.

**4.5 Tobit Regression**

The Tobit model was estimated using maximum likelihood estimator in STATA and data collected from the sample survey. Table 3 presents the Tobit regression (adjusted for

heteroskedasticity) parameters for the adoption of Minimum tillage. The dependent variable is the area cultivated using Minimum tillage. The model had a log likelihood of -73.56 and was done for 74 observations of which 32 were censored at area equals to zero for households that do not use Minimum tillage, and 42 were uncensored.

**Table 3 Tobit Regression Parameter Estimates for Adoption of Minimum Tillage (Dependent Variable: Area Cultivated under Minimum Tillage)**

| Variables | Marginal effect dy/dx | Std. Err. | ey/ex (Elasticities) |
|---|---|---|---|
| **Intercept** | 1.4252 | 1.2345 | |
| Household Size | 0.3544** | 0.2123 | 0.26456 |
| Sex of Household Head | 0.4688 | 1.78580 | 0.15422 |
| Age of Household Head | -0.59773** | 0.1783 | -0.06772 |
| Education of the Household Head | -0.1049* | 0.67445 | 0.11287 |
| Married Male Head | 0.3511 | 0.4061174 | -0.017482 |
| Dependency Ratio | 0.56388 | 0.467288 | 0.0632 |
| Total Cultivated Area in Ha | 0.657773 | 0.07633 | 0.386765 |
| Farm Size | 0.656673** | 0.056732 | 0.87653 |
| Distance | -0.356698 | 0.4765 | -0.076844 |
| Access to Technical Advice | -1.768489 | 1.3415182 | -0.8453399 |
| Livestock Ownership | -0.065811** | 0.0756774 | -0.2574654 |
| Sigma/ | 1.1247 | 0.11312 | |

**Source: Own survey (2007)**

**Note:** Significance level: *= at 10%, **= at 5%

From the table, it can be said that adoption of Minimum tillage is significantly explained by household size, age of the farmer, total farm size, education level of the farmer and livestock ownership. From the elasticity of -0.11287 of the education level of the farmer, it can be said that a 1% change in education of the farmer will result in a less than 1% change in the farmers' decision to adopt Minimum tillage. The sign in the coefficient of total farm size indicates that an increase in farm size will increase area under Minimum tillage. From the elasticity of 0.656673, it

can be said that a change in total farm size will result in almost proportionate change in a farmer's decision to adopt. The sign (+ve) in the coefficient of household size indicates that the larger the number of members providing labour, the larger the area under Minimum tillage. The positive sign of the coefficient of the age of the farmer in this study is considered to be negatively related to adoption based on the assumption that with age farmers become more conservative and less acceptable of new ideas. On the other hand, it is also argued that with age farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to use new technologies more efficiently. The study has revealed that with age farmers become more conservative and less acceptable of new ideas in the district.

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

The new technology of conservation farming specifically Minimum 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 Minimum tillage. The field data was analyzed in SPSS to produce descriptive statistics and the output was organized using EXCEL. OLS, EGLS and Tobit analyses were employed to analyze and discuss the individual factors hypothesized to affect the adoption of Minimum tillage. The factors studied included household size, sex of the household head, dependency ratio, level of education of the household head, marital status, distance to the main road, household size, farm size, total cultivated area, access to incentives, 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 in explaining the adoption of Minimum tillage in the district were household size, age of the farmer, education level of the farmer, farm size and livestock ownership. Minimum tillage is an essential technology to improving the food security of smallholder farmers.

## 5.2 Recommendations

- Researchers should continue to develop technologies that could be adopted by farmers for the purpose of high productivity gains, along side with simple and affordable implements. The government should introduce simple implements such as Magoye ripper at a reasonable cost so that farmers with smaller household sizes can use them. This would increase the adoption rates of Minimum tillage for it is labour intensive.

- Government should employ enough Agricultural Extension Officers so that they can adequately provide technical assistance necessary for adoption of Minimum tillage because the majority of the farmers have only attended primary school.

- Extension education should emphasize the importance of the technology by explaining its several agronomic and economic benefits to the 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 adoption of Minimum tillage, there will be a greater understanding of adoption of the technology. This will trigger new methodological approaches.

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# APPENDIX

## Appendix 1:

## Questionnaire

### An Assessment of the Factors Affecting the Adoption of Minimum Tillage in Sinazongwe District

**Section A: Identification Information**

District----------

Chiefdom Name----------

Camp Name----------

Date----------

Name of the Farmer----------

**Section B. Demographic Data**

1. Age as at last birthday ----------

2. Sex

   (a) Male---------- ☐

   (b) Female---------- ☐

3. What is your marital Status?

   (a) Male headed with one wife---------- ☐

   (b) Male headed more than one wife---------- ☐

   (c) Male headed Single---------- ☐

   (d) Male headed divorcee---------- ☐

   (e) Male headed widowed---------- ☐

   (f) Female headed married---------- ☐

   (g) Female headed single---------- ☐

   (h) Female headed divorced---------- ☐

   (i) Female headed widower---------- ☐

4. What is your highest level of Education?

   (a) Attended Primary---------- ☐

   (b) Completed Primary ---------- ☐

   (c) Attended Secondary---------- ☐

(d) Completed Secondary----------

(e) Attended College / University----------

(f) Completed College / University ----------

(g) Never attended School ----------

(h) Other, Specify ----------

5. What is your main source of income?

**On Farm Income**

(a) Sale of Crops----------

(b) Sale of Livestock----------

(c) Sale of farm assets----------

(d) Others, specify ----------

**Off-Farm Income:**

(a) Salary (formal)----------

(b) Gifts ----------

(c) Other business ----------

(d) Others, Specify_____

6. What is the total number of your household? ----------

**Complete the table below of your household status:**

| **Years** | **Children** | | **Dependants** | |
|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** |
| Between 0 – 15 | | | | |
| Between 14 – 36 | | | | |
| Above 35 | | | | |
| Total on each Section | | | | |

**Section C: Agricultural Data**

7. Have you been a farmer throughout your life?

a) Yes ----------

b) No ----------

8. If no to question 7, what have you been doing before you started farming?.....

9. What do you do apart from farming? _____

10. Have you ever heard about minimum tillage?

    (a) Yes---------- ☐

    (b) No---------- ☐

11. If yes to question 9, from who?

    (a) Government ---------- ☐

    (b) Friends---------- ☐

    (c) Other Specify---------- ☐

    (d) Village meeting ---------- ☐

    (e) Radio or TV---------- ☐

    (f) Publications ---------- ☐

12. What is the size of your farm? ---------- ☐ ----------(ha)

13. What size of your farm do you cultivate?----------(ha)

14. How much of it is under minimum tillage?----------(ha)

    Not applicable---------- ☐

15. And how much of it is under conventional tillage?----------

16. Did you receive training in minimum tillage?

    (a) Yes---------- ☐

    (b) No---------- ☐

17. If yes to question 16, who trained you?

    (a) Government ---------- ☐

    (b) NGOs ---------- ☐

    (c) Friends ---------- ☐

    (d) Others, Specify ----------

18. Do you have an access to?

| | | Yes | No |
|---|---|---|---|
| (a) | Technical assistance | [ ] | [ ] |
| (b) | Credit services | [ ] | [ ] |
| (c) | Incentives in form of inputs (Seeds or fertilizer) | [ ] | [ ] |

19. If yes, from who? Specify; _____

20. How much money do you spend as a household?

Per month _____ (kwacha)

Per Annual _____ (kwacha)

21. What is the main source of labour for minimum tillage?

| **Family Labour** | | | | **Hired Labour** | | |
|---|---|---|---|---|---|---|
| **Activity** | **Category Men, Women or Children** | **Number of People** | **Duration Number of Days** | **Number of People** | **Duration (Number of Days)** | **Payment Rate (Kwacha) Per Person** |
| Land Preparation | | | | | | |
| Planting | | | | | | |
| Weeding | | | | | | |
| Chemical Application | | | | | | |
| Fertilizer Application | | | | | | |
| Harvesting | | | | | | |

22. What is the main source of labour for conventional tillage?

| **Family Labour** | | | | **Hired Labour** | | |
|---|---|---|---|---|---|---|
| **Activity** | **Category Men, Women or Children** | **Number of People** | **Duration Number of Days** | **Number of People** | **Duration (Number of Days)** | **Payment Rate (Kwacha) Per Person** |
| Land Preparation | | | | | | |
| Planting | | | | | | |
| Weeding | | | | | | |
| Chemical Application | | | | | | |
| Fertilizer Application | | | | | | |
| Harvesting | | | | | | |

23. What was the main source your inputs? (Fertilizer and seed)

1. Own----------☐
2. NGOs----------☐
3. Cooperatives----------☐
4. Government ----------☐
5. Others, Specify _____

24. How do you obtain your inputs?

1. Buying with cash----------☐
2. Use of Credits----------☐
3. Given free ----------

25. If you used a credit, where did you obtain it?

26. If you did not use a credit, would you want to have an access to it next season?

1. Yes----------☐
2. No----------☐

27. Do you have an access to information about organizations offering Agricultural Credits?

1. Yes----------☐
2. No.----------☐

28. How far is your farm from the main road? _____

29. Do you think the distance from where your farm is affecting you from adopting minimum tillage? _____

1. Yes----------☐
2. No----------☐

30. If yes to question 29, can you specify, how? _____

_____

_____

31 Are there any benefits form Using minimum tillage?

1. Yes----------☐
2. No----------☐
3 not applicable----------☐

32. If yes to question 31, specify;

a) _____

b) _____

c) _____

d) _____

33. How much do you spend on: (in kwacha?)

a) Seed? _____

b) Fertilizer? _____