# FACTORS AFFECTING THE ADOPTION OF AGROFORESTRY IN ZAMBIA'S MUMBWA DISTRICT

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

**BY**

**NKANDU MWAKILIMA**

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## ABSTRACT

**Factors affecting the Adoption of Agroforestry in Zambia's Mumbwa District**

**Nkandu Mwakilima**
**University of Zambia, 2011**

**Supervisor:-**
**Ms. Diana Banda**

The background to the agro-forestry and sustainable agriculture in Zambia dates back beyond the 1950s. However, in the 1960s and early 1970s, the Government then deliberately encouraged the farmers, especially small-scale farmers to practice sustainable agriculture in general and Agroforestry in particular. This was a move to assist the small scale farmers replenish their soils without much dependence on inorganic fertilizers whose price had escalated then.

In year 2004, MACO and FD projected a 90% adoption rate by the year 2009. This prediction was made with reference to the overwhelming portrayed farmers' interest in agro forestry at that time. However, the district registered an adoption rate of only about 15% in the year 2009 and only 20% was predicted for the year 2010. The factors that affected the adoption of Agroforestry were unknown.

This study was carried out generally to determine the factors affecting the adoption of Agroforestry (Agrosylviculture in particular) in Mumbwa district. The specifics of the study were to determine the technological, social-economical and institutional factors affecting the adoption of Agroforestry in Mumbwa district and also to measure the extent to which each of the factors identified influenced adoption of Agroforestry in the district.

A sample of 150 households was randomly selected from four camps. Both primary and secondary data was collected in this study. The field data was analyzed in SPSS to produce descriptive statistics and a Tobit model, corrected for Heteroskedasticity was run in STATA.
After the running of a Tobit model, three factors were of significance at 95% confidence level. These were contact with extension agents, experience of a farmer and the number of hectares owned by a farmer. Contact with extension workers had the highest magnitude in affecting adoption of Agroforestry. The second most effective was the experience of a farmer and lastly, the hectares owned by a farmer.

From the study findings, it was recommended that the Government and NGOs such as CFU employ more extension workers so as to increase farmers contact with extension agents. It was also recommended that there be more programs that would advocate for Agroforestry practices as the farmers would easily capture this information and relate it to their farming experiences.

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background

Agroforestry is an interdisciplinary approach to systems of land use. Many agricultural specialists term Agroforestry as a Science based on, Forestry, Agriculture, Animal husbandry, Land Resource Management (LRM) and other disciplines. It is a collective name for land-use-systems and practices in which woody perennials are deliberately integrated on the same piece of land-management unit with crops and/or animals/pastures (Anthony Young, 1989; p). The main components of Agroforestry are trees and shrubs, pastures and livestock, together with the environmental factors of climate, soils and landforms. There are various Agroforestry practices which are distinctive arrangements of components in space and time. The main agro forestry practices include Agrosylviculture which looks at trees and crops, mainly or partly Sylvopastoral which is a combination of trees with pastures and livestock, tree component predominant, Entomoforestry (trees and insects) and Aquaforestry which incorporates trees with fisheries (ibid. p 12). This study, however, basically sticks to Agrosylviculture.

The background to the Agroforestry and Sustainable Agriculture (ASA) in Zambia dates back beyond the 1950s. However, in the 1960s and early 1970s, the Government then deliberately encouraged the farmers, especially small-scale farmers to practice sustainable agriculture in general and Agroforestry in particular. In trying to increase production per unit area to feed the ever increasing Zambian population, there has been from the late 1970s to date, a Government boosted encouragement and thus dependence on inorganic fertilizers and other inorganic inputs. The inappropriate usage of these inorganic inputs brought about an accelerated degradation and loss of productivity of farming land.

This, together with the ever escalating prices of the same inorganic inputs and unfavorable climatic factors such as drought, had resulted in increased food insecurity among many communities including those that used to be food secure like in Southern Province.

According to Kepa Zambia's programme officer, it was that realization which forced them in October 2004 to initiate Agroforestry and Sustainable Agriculture Days (ASAD). It was aimed at bringing together a number of non-governmental organizations (NGOs), MACO, Community based organization (CBOs), small-scale farmers and other likeminded civil society organizations to enhance their capacities in networking and sharing of best practices in collective processes to purposefully continue Agroforestry (AF) and sustainable farming (SF) activities and outreach work in selected target areas. Research in Agro forestry was initiated in 1983 by a NORAD funded project called the Soil Productivity Research Program in High Rainfall Areas (SPRP).

This study endeavors too bring to light the factors that are at play in the adoption of Agroforestry in Mumbwa district. The Agrosylvicultural trees which were introduced in the district included *Sesbania sesban, Cajanus Cajan, Tephrosia vogelli, Gliricidia sepium, Leucaena leucocephala and Acacia angustisuma.*

## 1.2 Problem Statement

The low adoption rate of Agroforestry techniques in Mumbwa district had been for a long time of concealed factors. The Ministry of Agriculture and Co-operatives (MACO) in conjunction with Forestry Department in the district had for the past six years intensified the dissemination of Agroforestry techniques to the small scale farmers in Mumbwa district. This followed after the farmer's plea over their inability to afford inorganic fertilizers which they termed as too extortionate. In spite of the currently resumed Farmer Input Support Program (FISP), farmers still brought out a common valid complaint that the fertilizer inputs which were acquired through this program were inadequate. Farmers still needed to buy more fertilizer bags per growing season if they were to realize a good harvest. In light of this, the farmers attended these seminars which were held by MACO and FD in large numbers and seeds for the various

Agrosylvicultural trees were given to them at zero cost. In year 2004, MACO and FD projected a 90% adoption rate by the year 2009. This prediction was made with reference to the overwhelming portrayed farmers' interest in agro forestry at that time. However, the district registered an adoption rate of only about 15% in the year 2009 and only 20% was predicted for the year 2010. Pertaining to the complaints which the farmers had made concerning the loss in soil fertility, increased soil erosion, poor soil structure and depreciation in soil organic matter, MACO and FD demonstrated how the trees would alleviate the farmers from such poor soil conditions. The factors that are affecting the adoption of Agro forestry in Mumbwa district still remained unknown. According to MACO, the farmers in Mumbwa district had an idea on the merits and the need for Agroforestry techniques in the area. However, only a few of them pointed to a tree they had grown. Despite farmers being taught on the benefits of Agroforestry and being empowered to carry out the technique by giving them free seeds, the adoption rate was still low. Hence, questions on why the adoption rate was low in the district kept on arising.

## 1.3 Objectives

### 1.3.1 General Objective

The study seek to determine the factors affecting the adoption of Agroforestry (Agrosylviculture in particular) techniques in Mumbwa district

### 1.3.2 Specific Objectives

- To determine the technological, social-economical and institutional factors influencing the adoption of Agroforestry in Mumbwa district
- To measure the extent to which each of the factors identified influence adoption of Agroforestry in the district

## 1.4 Rationale

Agroforestry is possibly a practice which would vindicate the small scale farmers in Mumbwa district from the `poor soils calamity.' it is worth pointing out that the farmers in the district are currently facing hardships to acquire enough fertilizers for the growing of maize and other food crops in the district. there is therefore, no doubt the need to intensify research in the aspect of Agroforestry, factors affecting its' adoption inclusive. This research will provide information which will be useful to various organizations such as MACO, CFU and FD. Good methods of implementation will therefore emancipate from the findings of this research. There currently exists no information on factors that affect the adoption of Agroforestry in Mumbwa district. However, studies have been done in places like Chipata but they cannot be made generic and assumed applicable to the Mumbwa case. This is because the farmers in Mumbwa are faced by a number of distinguishing situations in production that are different from those faced by the farmers in Chipata such as soil type, the cultural practices and traditional patterns of farming. Moreover, the study which was conducted in Chipata did not incorporate the aspect of farmers' income and its' possible effects on the adoption of Agroforestry in the district.

## 1.5 Structure of the Report

The report is divided into five (5) chapters outlined as follows: The introduction and background, statement of the problem, study objectives, study rationale are presented in chapter one. Chapter two contains a summary on the literature reviewed in the study and chapter three presents the research methodology. The study findings are presented and discussed in chapter four and Chapter five concludes the paper and outlines the recommendations.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 Introduction

This chapter discusses the meaning and definition of Agroforestry. It then highlights the major literature on the factors that necessitate Agroforestry, reasons why Agroforestry is difficult, advantages and disadvantages of Agroforestry, variables that are likely to adoption of Agroforestry, strategy and the conceptual models used to explain the decisions of farmers to adopt technologies.

## 2.2 Definitions and Scope of Agroforestry

Agroforestry is an interdisciplinary approach to systems of land use. Many agricultural specialists term Agroforestry as a Science based on, Forestry, Agriculture, Animal husbandry, Land resource management and other disciplines. It is a collective name for land-use-systems and practices in which woody perennials are deliberately integrated on the same piece of land-management unit with Crops and/or Animals/Pastures (Anthony Young, 1989; p). The main components of Agroforestry are trees and shrubs, pastures and livestock, together with the environmental factors of climate, soils and landforms. There are various Agroforestry practices which are distinctive arrangements of components in space and time. The main agro forestry practices include Agrosylviculture which looks at trees and crops, mainly or partly Sylvopastoral which is a combination of trees with pastures and livestock, tree component predominant, Entomoforestry (trees and insects) and Aquaforestry which incorporates trees with fisheries (p12). This study, however, will basically stick to Agrosylviculture. This is due to the fact that Agrosylviculture is the most prominently encouraged practice in the country. It will provide concerning the factor that are affecting adoption Agrosylviculture only.

However there are many other definitions of Agroforestry which were made by organizations such as The International Centre for Research in Agroforestry (ICRAF).

The organization defined Agroforestry as the simultaneous management of land for the production of food crops and trees. ICRAF further defined Agroforestry as a collective name for land-use systems and technologies, where woody perennials (trees, shrubs, palms, bamboos, etc) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of special arrangement or temporal sequence. In Agroforestry systems, there are both ecological and economical interactions between the sustainability framework in its' definition.

Recently, the following modification was made to incorporate the 'new' sustainability framework:' Agroforestry should be reconsidered as a dynamic, ecological based natural resource management system that, through the integration of trees in farm and rangeland, diversifies and sustains production for increased social, economic and environmental benefits' (Leakey, 1996).

Another author, Wyant (1996), stated that for an AFOs to become successful, it must comply with an inherent "ecosystem integrity" which he defined as the ecological integrity of an Agroforestry is a state of system development in which the habitat structure, natural functions and species composition of the system are interacting in ways that ensure its' sustainability in the face of changing environmental conditions as well as both internal and external stresses.

## 2.3 Definitions and Meaning of Adoption

The term adoption has been defined in many interesting ways. To give an illustration, Farlex Clipart collection 1999, defined an adoption as a legal proceeding that creates a parent to child relationship between two people not related by blood. The adopted child is entitled to all the privileges belonging to a natural child of the adoptive parents including the right to inherit (ibid: p675). There is an element of two parties who were initially not a family joining together to become one.

## 2.4 Reasons for Agroforestry (Merits)

Agroforestry on the nutritional content of the soil (Anthony: 1984). An experiment was done in Zambia by Chirwa, Mafongoya, et.al. The aim of the experiment was to compare the improvements in the soil by selected fallow species with continuous maize, with and without fertilizer. It was discovered that the roots of Sesbania sesban could go as deep as 400cm into the soil. The tree then fixes the leached nitrates and returns the nitrogen to the leaves. It then drops the leaves and when they decompose, they leave the soil with even more nitrogen than before.

Agroforestry also increases on the soils biomass (Koopmans etal: 1982, p74). Soils organic matter can be maintained at levels satisfactory for soil fertility. According to Bennama, et.al, (1981) Agroforestry reduces soil erosion by providing a soil cover by the leaves of the tree. However, he was criticized by Wiersum, (1985) who discovered that raindrop energy is not substantially reduced by a tree canopy. Though the tree might reduce the terminal velocity of the rain before it hits the ground, they also increase the drop size of the rains. This leads to large water masses that hit the ground and increases erosion (Anthony: 1989, p53). For instance, Acacia auriculiformis plantation in java increased erosive power by 24% (Wiersum, 1985). It was therefore concluded that the potential of many Agroforestry systems to maintain or improve soil organic matter will help to check for erosion but cannot be expected to greatly reduce it where conditions of climate, slope and soil cover are adverse (ibid).

A study was done in the years 1995 by Mangofoya et.al to screen species (Agroforestry trees) that could improve fallows after 3 years, to study the impact of such fallows on soil changes and crop yields and to evaluate the consequences of improved fallows on nutrient and water uptake by the crop. Maize was planted on three portions of land which was tested to have the same nutrient properties before the experiment was done. The first portion was not fertilized, the second portion was not fertilized and the last portion had Gliricidia sepium planted together with maize. By the period between 1995 and 1996, the yield of maize on the fertilized portion increased from 2.0 to 2.5 tons per hector. The maize that was planted with the incorporation of Sesbania sesban increased yield from 4.0 to 6.0 tons per hector. This showed that Sesbania sesban impacted because of the increase in the yield compared to unfertilized maize.

### 2.5 Summary of Variables Likely to Affect Adoption of Farming Technology

There have been various studies which have identified the variables that affect the adoption of new technologies. These variables can be determined to ascertain their effect on adoption of technologies. According to Jaeger and Malton (1990), the availability of adequate farmland to allow expansion of cultivated area was cited as a necessary condition for profitable adoption.

Baidu-forson (1999) concluded that adoption is strongly affected by the individual's investment risk attitude and contact with extension. Shapiro et al. (1992) also highlight the importance of risk perception and the availability of off-farm income to serve as an alternative source of income to purchase or hire the technology. The role of extension is also widely perceived as important although Mwila (1995) observed that there is also transfer of knowledge among farmers in some areas without the interference of extension workers. This is diffusion based on human capital and land constraints. Their model postulates that farmers with more education and larger land will hold more knowledge of improved farming systems and are likely to adopt technology more rapidly. Isham (2002) extends the model of Feder and Slade (1984) by incorporating social capital as a fixed input into the decision to adopt technologies. This extended model predicts that farmers with neighbors that adopt the technology and those with higher levels of social capital accumulate more information and adopt technology more rabidly. The influence of age of household head on adoption of technology is inconsistent in the literature reviewed some show no relationship (Baidu-forson, 1999; Shapiro et al, 1992). Savadogo et al.(1998) shows significance in certain areas.

The factors influencing technology adoption decisions include farm size, risk exposure and capacity to bear risks, human capital, labour availability, land tenure, access to financial and produce markets, access to information, participation in off-farm activities, social capital, household characteristics and ecological and environmental factors. Gom (2002) attributes the low rate of technology adoption in the smallholder agricultural sector to the problem of incomplete financial markets, an argument empirically supported in a study by Green and Ng'ong'ola (1993) and Zeller et al. (1998). Green and Ng'ong'ola (1993) found that tobacco farming, improved variety, access to credit, participation in off-farm activities and regular employment are the main factors influencing fertilizer adoption in Malawi.

## 2.6 Conceptual Framework

Batz et al (1999) identifies two conceptual models used to explain the decision of farmers to adopt technologies. These are the innovation-diffusion model and the economic constraints model. According to the innovation-diffusion model, a technology is transferred from the source to the intended end users by extension workers. Diffusion of this technology depends on the personal characteristics of the potential users. The model assumes that a technology is ready for use unless it is hindered by inefficient communication. The economic constraint model assumes that the adoption of technology is determined by the distribution of resource endowments among end users. Negatu and Parikh (1999) present a technology characteristics-user's context model that integrates approaches which assume that agro-ecological, socioeconomic and institutional characteristics of the technology's intended end users have a central role to play in the adoption decision and diffusion process. This model looks at all aspects included in the innovation-diffusion and the economic constraints models and characteristics of the technology being introduced.

According to Baidu-Forson (1999) and Shapiro et al (1992), a farmer's decision to adopt a technology is based on the assumption of utility maximization. Subjective utility coming from survey respondents can be used to measure perceived differences in adoption of technology, in this case crop diversification strategy. Empirical models that have been used to study adoption include Probit, Logit and Tobit. Probit and Logit models use a binary variable that takes a value of one if the decision maker has adopted the technology in question, and zero otherwise. While these two models have wide empirical application in adoption studies, they have been criticized for their failure to measure and account for the extent of adoption. This loss of information is prevented by using the Tobit model (Baidu–Forson, 1999; Shapiro et al. 2002).

## 2.7 Analytical Framework

The Tobit model also known as the Censored regression frame work (after Tobin, 1958) 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 crop diversification strategy use if the latter is defined as the proportion of total cultivated land area that is allocated to other crops other than maize since, in this study; crop diversification is looked at in terms of less reliance on maize. In the Tobit model context, the preference of the ith farmer for crop diversification strategy can be presented as;

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{otherwise,} \end{cases} \qquad \text{.........(1)}$$

Where $y_i$ is the area that was diverted into other crop varieties, and the latent variable $y_i^* = \beta x + \mu_i$ , where $x$ is a vector of explanatory variables postulated to explain the variation in the number of other crops grown in the area other than maize, $\beta$ is a vector of parameters to be estimated, and $\mu_i$ is the independent normally distributed random error term with zero mean and constant variance , that is $\mu_i \sim N\left(0, \hat{\sigma}^2\right)$. In summary, the model is specified as follows:-

$$Y = \beta 0 + \beta 1 x_1 + \beta 2 x_2 + \beta 3 x_3 + \beta 4 x_4 + \beta 5 x_5 + \beta 6 x_6 + \text{........}(2)$$

Where:-

$Y$ Is the proportion of land under Agroforestry

$x_1$ Is the household head age

$x_2$ Is the household size

$x_3$ Is the household level of education

$x_4$ Is the gender of the household head

$x_5$ Is the number of years in farming (experience)

$x_6$ Is the contact with extension workers which shall take the value of 1 if contact is there and 0 if not

$x_7$ Is access to organic fertilizers which shall take the value of 1 if access is there and 0 if not

$x_8$ Is off farm income

$x_9$ Is the number of household members who supply labour on the farm

$x_{10}$ Is farm size

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:-

$$E_y = F(z)E_{y^*} \quad \text{.........} (3)$$

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:-

$$\frac{\delta E_y}{\delta X_k} = F(z)\left(\frac{\delta E_{y*}}{\delta X_k}\right) + E_{y*}\left(\frac{\delta F(z)}{\delta X_k}\right) \quad \text{.........} (4)$$

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 3
# METHODS AND PROCEDURES

## 3.1 Introduction

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

## 3.2 Study Area

The study was conducted in Mumbwa district of Central province. The district located 150km to the west of Zambia's capital city (Lusaka) It covered four agricultural camps which were selected through a simple random sampling procedure. These were Kabwanga, Moono, Mumba and Chibila camps. They all consisted of small holder farmers from various villages. Mumbwa district was selected because it is one of the many districts in which organizations such as CFU and MACO are currently carrying out projects on Agroforestry.

## 3.3 Research Design

A case study under non experimental research design was used in this study. This design was used because farmers in the four camps are not divided into groups based on their similarities i.e. control and target groups were considered to be as part of one group. A case study was made use of so as to capture a deeper understanding of the factors that affect the adoption of Agroforestry in the district.

### 3.4 Study Population and Sampling Procedure

A sample of 150 households was both randomly and purposively selected from the villages in the four camps. Random sampling was done using farmer registers held by MACO. A farm household was considered a sampling unit in the study.

### 3.5 Data Sources and Collection Techniques

Both primary and secondary data was collected in this study. Primary data was collected by means of structured questionnaires administered through interviews with the famers. Secondary data was collected from the Ministry of Agriculture and Cooperatives (MACO), the Conservation farming unit (CFU), Kepa Zambia and from relevant publications.

### 3.6 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 have been present across farms due to the use of cross sectional data. Heteroskedasticity was considered significant at 5% level. A Tobit model, corrected for Heteroskedasticity was run in STATA.

# CHAPTER 4
# RESULTS AND INTERPRETATIONS

## 4.1 Descriptive Statistics

### 4.1.1 Household Sizes

The households in Mumbwa district are more confined in an extended family set up. These families consist of different relations among its' members. Household size is important in the study as it expected to have a bearing on farmers' adoption of technology. The table below shows the distribution of farmers by their household sizes.

**Table 1: Household Sizes**

| Household size | Number | Percentages |
|---|---|---|
| 1-3 | 13 | 8.6 |
| 4-6 | 47 | 31.4 |
| 7-11 | 63 | 42 |
| 12&> | 27 | 18 |
| Total | 150 | 100 |

Source: Own survey data (2010/12)

The majority of the households had members amounting between 7 and 11 people. These accounted for 42% of the study sample size. 32% of the households had members ranging from 4 to 6. These types of households were mainly new families or families in which the household heads were old people and their children had resettled to other lands. Though the number seemed small, they were still in most cases, extended families. Through the study, it was further learnt that 17% of the households in the study sample had people ranging from 12 members and above. These were large extended families and in most cases, their family labour supply was high compared to the other few member households.

There were also the rarest households which consisted of 1 to 3 members only. These accounted for 8% of the 150 households in the study population. Out of these families, five (5) were new nuclear families which consisted of a father, mother and a child. The rest were still confined under an extended family set up.

### 4.1.2 Farmer's Levels of Education

The levels of education attained by the farmers in the sample area where captured in the study. This is because literature outlines some significance of a farmer's education level in relation to his or her adoption tendency. The table below shows a cross tab between gender and level of education.

**Table 2: Farmer's Levels of Education**

| | **Highest level of education attained by farmer** | | | | | |
|---|---|---|---|---|---|---|
| | **None** | **Primary** | **Basic** | **High School** | **College** | **Total** |
| **Female** | 3 | 8 | 14 | 10 | 0 | 35 (23%) |
| **Male** | 9 | 35 | 28 | 40 | 3 | 115 (77%) |
| **Total** | 12 (8%) | 43 (29%) | 42 (28%) | 50 (33%) | 3 (2%) | 150 |

Source: Own survey data (2010/12)

The table above shows a cross tab between gender and level of education in the study sample. It can be noted in the last column that in the study, 23% of the household heads were women and the other 77% were men. The study brought to light the fact that the majority of the farmers in the study sample had attained high school education at most. These accounted for 33% of the sample size of these individuals, 20% were women and 80% of them were men.

The second largest group of farmers had attained at most primary education and these accounted for 29% of the study population. 19% of these farmers were female and the other 81% were male. Basic education was attained by 28% of the study population and in this category, 33% were women whilst 67% were men. Only 2% of the study sample had attained tertiary education. In every category of educational level, more men were privileged than the women. This attributes to two possible explanations, the first one being that in the study, more men were registered as household heads than the females therefore, sample demographics would show a bias towards the male counterparts. The second explanation is captured from the fact that the school enrolment levels of the females have for many years been dominated by those for men. Women have since the past, undergone a lot of cultural hindrances to enroll in schools at the same level as men.

It is however, worth mentioning that the levels of education in the study sample had no profound bearing on the adoption rates of Agroforestry by the farmers on the study.

### 4.1.3 Adoption of Agroforestry

Adopters in this study were defined as farmers who allocated a portion or all their land to Agroforestry practices. The non adopters were those farmers that did not allocate any proportion of their land whatsoever, to Agroforestry production. Gender is also assumed by many authors to have a bearing on ones' choice to adopt a technology or not. The table below shows how male and female household heads adopted Agroforestry.

**Table 3: Adoption of Agroforestry**

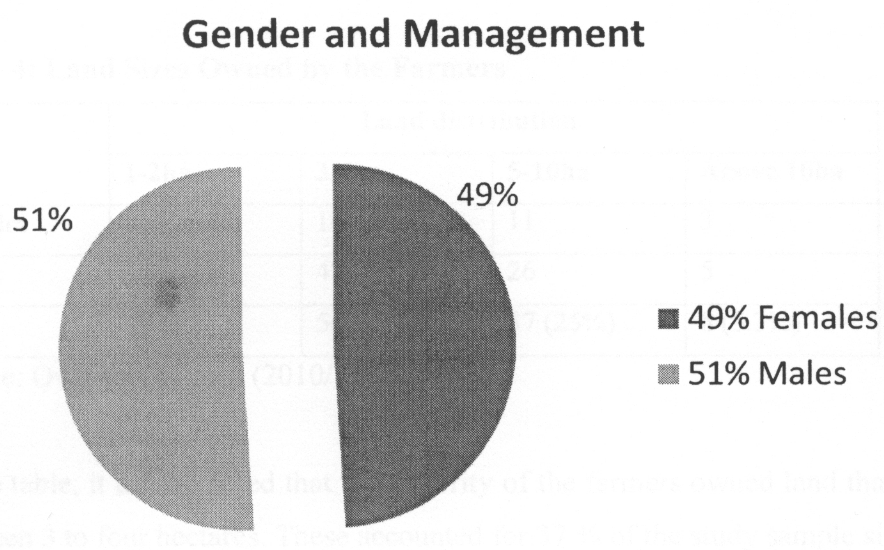
| | **Adoption of Agroforestry** | | |
|---|---|---|---|
| | No | Yes | Total |
| **Females** | 8 | 27 | 35 |
| **Males** | 21 | 94 | 115 |
| **Total** | 29 (19%) | 121 (81%) | 150 |

Source: Own survey data (2010/12)

In table 3 above, it can be deduced that 81% of the farmers in the study population adopted the Agroforestry technique. Among the adopters, 27 (22%) of these were women and 94 (78%) were men. On the other hand, 19% of the farmers in the study sample were non adopters and of these, 8 (28%) were female and the other 21 (72%) were male.

This table does not however deduce the adoption rates that were prevailing in the study. It does not bring out the proportions of land that were allocated to Agroforestry by each farmer which will be discussed later in the report. The table further shows that there were more adopters than non adopters in the study, but this offsets the fact that the proportions of land that were allocated to Agroforestry production by the adopters were still very low.

**Figure 1: Gender and Management**




Source: Own survey data (2010/12)

In the rural set up, men are mostly considered to be the managers of most farm activities. This is because they are the ones who usually make decisions on the farm. This research however brought to light a very interesting issue on women's participation in management of farm activities. The bar chart above shows the degree of farm management performed by men in relation to women. This information was acquired by a way of observing the participation of the household heads and comparing them to their spouses. It was learnt that in most of the families where the male household heads were above 75 years of age, their spouses performed a lot of managerial functions. Women were also involved in the management of farm activities even in cases where their husbands were youthful. The actual farm management was shared almost equally between the males and the females.

### 4.1.4 Farmer's land Sizes

Table 4 shows the land sizes that were owned by the farmers and how this land was distributed among the men and the women in the study population. This land was mostly traditional land which has been granted to the farmers through their village headmen.

**Table 4: Land Sizes Owned by the Farmers**

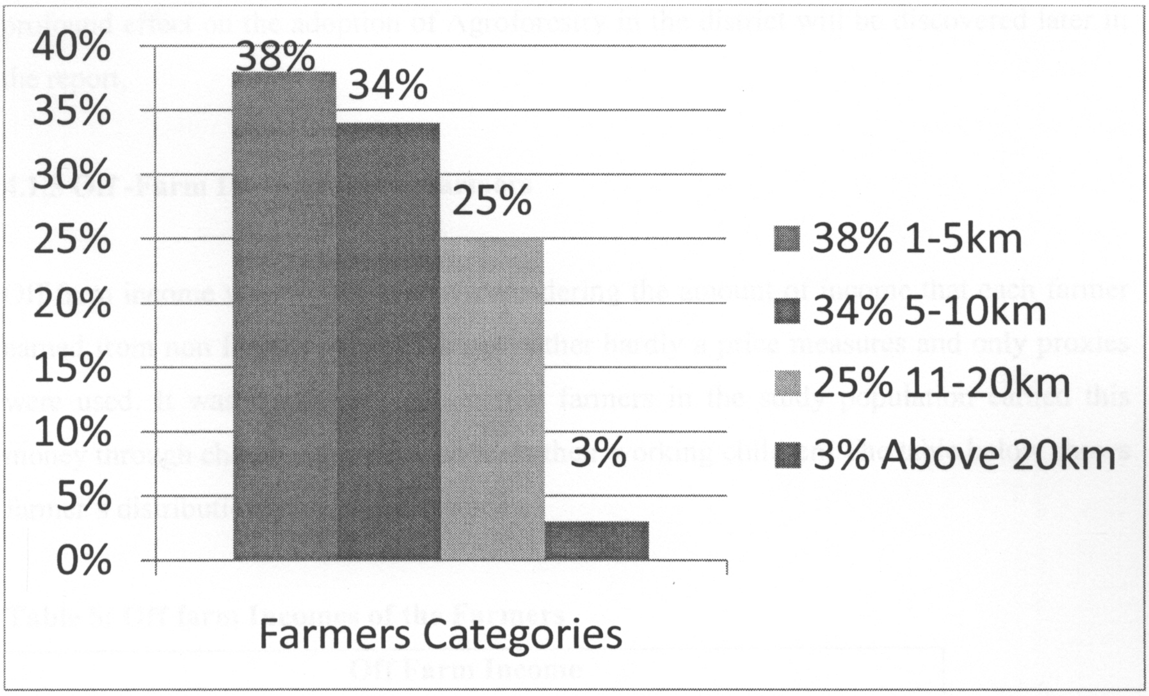
| | **Land distribution** | | | | |
|---|---|---|---|---|---|
| | **1-2ha** | **3-4ha** | **5-10ha** | **Above 10ha** | **Total** |
| **Females** | 5 | 14 | 11 | 3 | 35 |
| **Males** | 44 | 42 | 26 | 5 | 115 |
| **Total** | 49 (33%) | 56 (37%) | 37 (25%) | 8 (5.3%) | 150 |

Source: Own survey data (2010/12)

In the table, it can be noted that the majority of the farmers owned land that was ranging between 3 to four hectares. These accounted for 37 % of the study sample size. More men owned this land compared to women. This can be verified in the fourth column table. which shows that out of the 56 farmers who owned land ranging between 3 to 4 hectares, 14 (25%) were women and 42 (75%) were men. The second largest category of farmers possessed land that was ranging between 1 to 2 hectares. These farmers accounted for 33% of the study population. These lands were also accrued to more men that the women in the study area. Out of the 49 farmers who owned this land, 5 (10%) were female and the other 90% were male. 25%of the farmers in this study owned land which was ranging between 5 to 10 hectares and only 8% had land amounting to 11 hectares and above.

The study revealed that in most cases, farmers who were located 1 to 5km away from the market area owned at most, the 1 to 2 hectares of land each. This was attributed to the fact that settlements that were nearer to the market area were more densely populated than those that were far away from the market. In light of this, 8% (farmers who owned 11 hectares and above) were located 11 kilometers and above away from the market.

**Figure 2: Distance of Sample Farmers from Main Market**




Source: Own survey data (2010/12)

The bar chart above postulates how far the farmers in the study were from the main market in Mumbwa district. The differences in the distances came about because the study involved selection of farmers from four different camps. These camps were Kabwanga, Moono, Mumba and Chibila. The majority of the farmers were from Mumba camp which was located 5km away from the market place. These farmers were mostly characterized by smaller pieces of land ranging from 1 to 3 hectares. This was due to the high population of farmers who had to share the available land in equal proportions. Another 36% percent of the farmers were based in Kabwanga camp which was situated about 7km to the northeast of the main market area. These farmers had much bigger portions of land ranging from 3 to 6 hectares each. Farmers in Chibila camp are located between 11 and 15 kilometers away from Mumbwa town area. These accounted for about 25% of the study sample size and only 3% of the farmers were from Moono camp.

It was learnt that the further away places (Chibila and Moono camps) were not frequently visited by extênsion officers in the district. These farmers also had difficulties when it came to attending seminars and fieldays which were held by MACO. Whether this had profound effect on the adoption of Agroforestry in the district will be discovered later in the report.

#### 4.1.5 Off -Farm Incomes of the Farmers

Off farm income was determined by considering the amount of income that each farmer earned from non far activities. This was rather hardly a price measures and only proxies were used. It was learnt that 32% of the farmers in the study population earned this money through charcoal burning and from their working children. The table below shows farmer's distribution by off farm incomes.

**Table 5: Off farm Incomes of the Farmers**

| **Off Farm Income** | | |
|---|---|---|
| **ZMK** | **Numbers** | **Percentage** |
| **None** | 5 | 5.3 |
| **'000'** | 25 | 26.3 |
| **'00,000'** | 60 | 63.7 |
| **'000,000'** | 5 | 5.3 |

Source: Own survey data (2010/12)

Table 5 above shows how the off far incomes were distributed among the farmers. 64% of the farmers earned off farm income that was in hundred thousands of kwacha. These incomes were mostly attained from charcoal burning, working children and other relatives and also by sending off their children to work on other farms for a pay.

Secondly, another set of farmers earned thousands of off farm income. These accounted for 26% of the study population and the mainly earned this income by sending off their children to provide labour on other farms. 5.3% of the farmers received millions of off farm income and these were usually farmers who were also civil servants. Another 5% of the study sample did not record any source of off farm income. These were wholly dependent on farm activities for their income.

## 4.2 Tobit Model Results

The Tobit model was run in stata and produced the adove results. the model specified the significant variables and also the extent to which each of the variebles affected the adoption of Agroforestry in Mumbwa district. All the variables were tested at 95% level of confidence, therefore, every variable that produced a P value less than 0.05 has significance in affecting the adoption of Agroforestry.

**Table 6: The Tobit Model Results**

| Variable | Coefficients | Marginal Effect | Standard Error | P Value |
|---|---|---|---|---|
| **Household size** | 0.041 | --- | 0.648 | 0.150 |
| **Gender** | -0.137 | --- | 0.149 | 0.449 |
| **Age** | -0.358 | --- | 0.873 | 0.683 |
| **Education** | 0.187 | --- | 0.509 | 0.715 |
| **Experience** | 0.228 | 0.228 | 0.527 | 0.034** |
| **Marital status** | 0.058 | --- | 0.102 | 0.401 |
| **Family Labour** | 0.007 | --- | 0.707 | 0.275 |
| **Land Size** | -0.178 | -0.178 | 0.637 | 0.040** |
| **Off farm income** | -0.125 | --- | 0.454 | 0.786 |
| **Extension contact** | 0.544 | 0.544 | 0.152 | 0.026** |
| **Constant** | 1.109 | --- | 0.458 | 0.018 |

$R^2 = 0.6705$

P** = significant at 95% confidence level

### 4.2.1 Model Interpretation

In the model results, it can therefore be deduced that variables of Experience, Land Size Owned by Farmers and contact with extension agents were significant. These variables had P values less than 0.05. As shown by the$R^2$, the model explained the variations in the adoption dependent variable (proportion of land under Agroforestry) 67.05%. This means that 67.05% of the adoption dependent variable variations with regards to each household were explained by the independent variables in the model. Below is an individualistic interpretation of the significant variables:-

**a) Experience**

Experience was determined by the number of years that a particular farmer has been involved into farming. Farmers who had been in farming for a period of between 1 to 5 years were considered to be less experienced. Those that were in the farming venture from 6 to 10 years were of medium experience. The highly experienced farmers were those who had been farming for 11 and above years. In the table above, it can be seen that the experience variable had a positive coefficient value of 0.228. This means that the number of years in farming portrays a positive effect on the adoption of Agroforestry in Mumbwa district. In other words, it can be said that the higher the level of farming experience a farmer has, the most likely they are to adopt Agroforestry. The experience variable had a marginal effect value of 0.228. This value is equivalent to 22.8%. This means that the level of experience that a farmers has affects the adoption of Agroforestry by 22.8%. In this study, it can be said that for every unit increase in the experience of a farmer (5 years), this would increase a farmer's allocation of part of his land to Agroforestry by 22.8%. It is worth mentioning that these values are more of probabilities than actual values. Therefore, in some cases, a farmer who has more experience may even adopt Agroforestry to a lesser extent.

**b) Land Size Owned by Farmers**

There were variations in the land sizes that were owned by the farmers in the study population. The Tobit model produced a negative coefficient value of -0.178 for this variable. This means that a unit increase in the land owned by a farmer would actually reduce the proportion of his/her land allocated to Agroforestry. For example, if two farmers own 2ha and 10ha pieces of land respectively and they use 2ha of their land on Agroforestry, it means that the first farmer uses up 100% of his/her land on Agroforestry. The farmer who owns 10ha of land would only use 20% of his/her land on Agroforestry. This explains why the land variable has a negative coefficient. The marginal effect caused by this variable is -0.178. This is equivalent to -17.8%. From this value, it can be explained that a unit increase in the land owned by a farmer reduces the proportion of land allocated to Agroforestry by 17.8%. This can also be explained by literature which says that farmers can adopt more of a technology only if the technology returns more income than the cost of expanding land operations within the short run (Jaeger and Maltlon, 1990). The availability of adequate farmland to allow expansion of cultivated area is also cited by Jaeger and Matlon (1990) as a necessary condition for profitable adoption. This is only applicable if farmers perceive the new technology as profitable as possible. Therefore, it can also be concluded that farmers who had more land in Mumbwa district might have not adopted Agroforestry on a large scale because they did not perceive it as a venture that would yield more returns than benefits.

**c) Contact with Extension Agents**

This variable was a monthly measure. The number of months in a year in which farmers had physical contact with extension agents varied mostly by location and distance. Farmers who did not or only had up to two months of contact with extension agents were considered the less contacted. Those who had contact with extension agent for 4 to 5 months in a year were the medium contacted. The highly contacted experience 6 to 12 months contact with agents in a year. In table.. it can be noted that the extension contact variable produced a positive coefficient value of 0.544. This simply shows a positive relationship between frequency of farmers' contact with extension workers and adoption of Agroforestry. The Tobit model produced a marginal effect value of 0.544 which is equivalent to 54.4%.The value shows the magnitude of change that is brought about by the variations in farmers' contact with extension agents. Provided there is a unitary increase in the number of months in which a farmer gains contact with an extension agent in a year, this increases his/her adoption of Agroforestry by 55.4%. This model outcome correlates to theory. Baidu-forson (1999) disclosed that adoption of new technology is strongly affected by the individual farmers' investment risk attitude and contact with extension. However, this interpretation does not always hold true. It is only a measure of the increase in the probability of a farmer to adopt. There could be cases where a frequently contacted farmer would not even adopt Agroforestry at all.

It can therefore be concluded that contact with extension agents is the most influential variable that affects the adoption of Agroforestry in Mumbwa district. This is so because the variable registered the high Marginal Effect value of 55.4%. Number of years in farming (experience) was the second in magnitude of effect of Agroforestry. This variable recorded a Marginal Effect value of 22.8%. The hectares variable had the least effect on adoption of all the significant variables. The variable had a 17.8% Marginal Effect on the adoption dependent variable.

# CHAPTER 5
# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This chapter concludes the research finding and offers the recommendations that are appropriate in order to assist in solving some of the problems that were discovered during the course of the research.

## 5.2 Conclusion

The study found that farmers had adopted Agroforestry practices and that the level of experience that an individual farmer had, the frequency with which an individual farmer had contact with extension agent(s) and the size of land in hectares that a farmer owns constituted factors that influenced farmers to adopt such practices. The most influential variable affecting the adoption of Agroforestry in Mumbwa district was contact with extension agents.

The more farming experience that a farmers had the more likely they would adopt Agroforestry practices. However, the study showed that the hectares variable among all others had the least effect on adoption of Agroforestry. The study found that a unit increase in the hectares owned by a farmer reduces the proportion of land allocated to Agroforestry.

## 5.3 Recommendations

There is need for Government and NGO such as CFU to look into the current staffing with a view to employ more extension workers so as to increase farmers contact with extension agents. This can lead to adequate extension worker to farmer exchange of ideas and knowledge on Agroforestry, hence, increasing on the likelihood of farmers to adopt the practices.

Since the majority of the farmers in the district have been farmers for a long time, there levels of farming experience are high and this creates a good atmosphere for adoption. It is therefore, worth recommending that there be more programs that would advocate for Agroforestry practices because the farmers would easily capture this information and relate it to their farming experience. These programs can be seminars, Field Days, lessons, watch and learn tours to mention a few.

There is need for the Government and other organizations such as CFU to provide more Agroforestry seeds and technical assistance to the farmers as they increase their farm land so as to increase the proportion of land under Agroforestry.

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## APPENDIX

QUESTIONNAIRE

*Questionnaire serial number:* [ | | ]

**Factors affecting the Adoption of Agroforestry in Zambia's Mumbwa District**

*The University of Zambia*

*Department of Agricultural Economics & Extension Education*

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*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 write some answers in the tables, boxes & blank spaces provided.*

---

1. **Farm identification**

1.1 Ward code **ward** [ | ]

1.2 Farm code **farm** [ | ]

1.3 a) Name of farm owner **own** ____________________

b) Sex of farm owner (0=Female; 1=Male) **sex** [ ]

c) Which year was farmer owner born (e.g. 1967) **yob** [ ]

1.4 Is the owner the main respondent? **Rown** [ ]

0 = No

1 = Yes→ *Go to question 1.8*

1.5 a) Name of main respondent **resp**__________________

b) Relationship to farm owner **rship** [ ] (Codes at bottom of Table 2.1)

*Ensure that the main respondent is knowledgeable about the farm, and Agroforestry practices.*

1.6 Did this farm práctice Agroforestry last year (2009)? **Prod** [ ]

0 = No → *Fill in questions 1.9 through 1.13*

1 = Yes

1.7 Response status (1=Complete; 2=Did not practice Agroforestry; 2=Refusal; 3=Non-contact) **status** [ ].

1.8 Date of interview (dd/mm/yy) **daten** [ / / ]

1.9 Name of interviewer__________________ Interviewer code **intr** [ | | ]

1.10 Date checked (dd/mm/yy) **datec** [ / / ]

1.11 Name of field supervisor _____________ Supervisor code **sup** [ | | ]

## 2. Demographics

2.1 I now would like to ask you a few questions about each of the members of your household/farm family. I will also ask about the farm manager if there is one.

| an you please ive me the ames of the embers of the ousehold? tart with the arm wner/head. | | What is ...'s sex? 0=Female 1=Male | When was ... born? | | What is ...'s marital status? 1=Single or under-age 2=Married 3=Divorced or separated 4=Widowed | What is the highest level of **education** attained by ... **See code below** | What is ...'s <u>relationship</u> to the head? **See code below** | Did ... provide farm labour the past 12 months? 0=No 1=Yes | Did ... earn any income during the past 12 months (farm or off-farm)? 0=No 1=Yes |
|---|---|---|---|---|---|---|---|---|---|
| 1em er ode | Member name | | Month **Codes below** | Year (e.g. 1967) | | | | | |
| **1ID** | **NAME** | **DM01** | **DM02** | **DM03** | **DM04** | **DM05** | **DM06** | **DM07** | **DM08** |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

### *3.2 Dependence/income*

*3.2.1. Fill in the following table income earned by farm members between October 2009 and November 2010.*

| List all income-earning members of the household/farm (i.e. those with DM08=1 in Table 2.1 above) | | How much income did …earn from the crops under Agroforestry (ZMK)? **Enter '0' if none** | How much income did … earn from other farm activities (ZMK)? Add across all other farm activities. **Enter '0' if none** | How much income did … earn from off-farm activities (ZMK)? Add across off-farm all activities. **Enter '0' if none** | Ask only if **IN03** What was …'s mo important off-farn activity? **See codes below** |
|---|---|---|---|---|---|
| **MID** | **Name** | **IN01** | **IN02** | **IN03** | **IN04** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

*3.2.2. Fill in the following table income earned by farm members 12 months before November 2010..*

| List all income-earning members of the household/farm (i.e. those with DM08=1 in Table 2.1 above) | | How much income did … earn from Agroforestry planted crops (ZMK)? **Enter '0' if none** | How much income did … earn from other farm activities (ZMK)? Add across all other farm activities. **Enter '0' if none** | How much income did … earn from off-farm activities (ZMK)? Add across off-farm all activities. **Enter '0' if none** | Ask only if **IN08** What was …'s m important off-farr activity? **See codes below** |
|---|---|---|---|---|---|
| **MID** | **Name** | **IN05** | **IN06** | **IN07** | **IN08** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Off-farm income sources (IN04 & IN08)**

| | | | |
|---|---|---|---|
| 1=on smallholder farm<br>2=on commercial farm<br>3=in factory<br>4=in a mine<br>5=other industrial work<br>6=teacher<br>7=other civil servant<br>8=clerk<br>9=shop attendant<br>10=non agricultural piece work | 21=agricultural trading<br>22=livestock trading<br>23=retailer/shop owner<br>24=hawker/vendor/marketer<br>25=firewood/charcoal production<br>26=carpentry<br>27=builder<br>28=local brewing<br>29=butchery(all meats including game, cooked or uncooked) | 30= services (e.g. ploughing, planting, spraying)<br>31=milling<br>32=oil processing<br>33=agro-processing<br>34=tailor<br>35=bicycle repair<br>36=weaving<br>37=blacksmithing<br>38=traditional doctor | 39=fishing and selling<br>40=precious stone min<br>(small scale)<br>41=other (specify) |

*3.3 Organizational capital*

3.3.1 Are you a member or partner in a (0=No; 1=Yes).
a) Cooperative **hh17** [ ] b) Association/farmer group **hh18**

3.3.2 Does your farm collaborate with other farms in the following activities (0=No; 1=Yes).
a) Buying inputs **hh19** [ ] b) Marketing of milk **hh20**

*3.3.3 Fill in the following table about the services received by the farm and their providers.*

| Service and its description | | Has this farm ever received assistance with or info on …?<br>0=No→ Go to next service<br>1=Yes | Which year did you first receive help/info on…?<br><br>Enter year (e.g. 2001) | Who is/was the most important supplier or organizer of this service?<br><br>**See codes below** | How did you receive (info on) this service?<br><br>**See codes below** | Did you use or receive this service during the past year (October 2009 – November 2010)?<br><br>0=No<br>1=Yes |
|---|---|---|---|---|---|---|
| **Service** | **Name/description** | **SR01** | **SR02** | **SR03** | **SR04** | **SR05** |
| 1 | Technical assistance in Agroforestry | | | | | |
| 2 | Training | | | | | |
| 3 | Inputs (trees used) | | | | | |
| 4 | Credit | | | | | |
| 5 | Farm machinery services | | | | | |
| 6 | Transportation | | | | | |
| 7 | Quality control | | | | | |
| 8 | Tree Management | | | | | |
| 9 | Marketing | | | | | |

**es for service provider (SR03)**

*ellow farmer(s)*
*armer*
*nization*
*rivate firm(s) or*
*mediaries*
*4=Government department*
*5=NGO or project*
*6=Bank*

**Codes for mode of service delivery (SR04)**

*1=Informal conversation*
*2=Radio program*
*3=Pamphlet/newspaper*
*4=Workshop*
*5=Field Day*
*6 =Demonstration plot*
*7 =Other (specify)*

3.3.4 Five years ago, did you belong to more, less of the same number of farmer organization?

1=More 2=Less 3=Same 4=Not applicable **hh21**[ ].

*3.4 Physical capital/assets*

*3.4.1 Fill in the following table about the farm's ownership of assets.*

| Asset type | | Does the farm have …? 0=No→ Go to next asset 1=Yes | How many … does the farm own? | Which year was the newest acquired? (e.g. 1999) | What is the current value of all …? (ZMK) | How many did the household have in November 2011? |
|---|---|---|---|---|---|---|
| **Asset** | **Name/description** | **AS01** | **AS02** | **AS03** | **AS04** | **AS05** |
| 1 | Tractor | | | | | |
| 2 | Motor vehicle | | | | | |
| 3 | Motor cycle | | | | | |
| 4 | Bicycle | | | | | |
| 5 | Ox cart | | | | | |
| 6 | Plough | | | | | |
| 7 | Wheel barrow | | | | | |
| 8 | Other tractor-drawn implements | | | | | |
| 9 | Grinding mill | | | | | |
| 10 | Residential building | | | | | |
| 11 | Television | | | | | |
| 12 | Computer | | | | | |
| 13 | Land telephone line | | | | | |
| 14 | Mobile phone | | | | | |
| 15 | Bank account | | | | | |
| 16 | Lounge suit/Sofa | | | | | |
| 17 | Bed | | | | | |
| 18 | Water pumps | | | | | |
| 19 | Crop/animal Sprayer | | | | | |
| 20 | Radio | | | | | |

*3.5 Credit access*

3.5.1 I now would like to ask you about the sources of funding that this farm uses and/or has used, and the farm's access to credits **(October 2009 – September 2010)** *Fill in the following table about the farm's sources of funding and access to credit.*

| Source of funding or credit | | Has the farm used … to finance investment in capital items?<br>0=No<br>1=Yes | Does the farm usually use … to finance inputs? (e.g. fertilizers, seed and labour)<br>0=No<br>1=Yes | Did the farm use … as a source of funding last year?<br>0=No<br>1=Yes | How much money did the farm receive from … last year (ZMK)? |
|---|---|---|---|---|---|
| **FUND** | **Description** | **CR01** | **CR02** | **CR03** | **CR04** |
| 1 | Retained earnings | | | | |
| 2 | Off-farm income | | | | |
| 3 | Bank | | | | |
| 4 | Family members, relatives | | | | |
| 5 | Farmer group | | | | |
| 6 | NGO or Project | | | | |
| 7 | Government | | | | |
| 8 | Intermediaries (buyers) | | | | |
| 9 | Fellow farmers or informal lenders | | | | |
| 10 | Other (specify) | | | | |

### 3.6 Size of Agroforestry production

3.7.1 What is the total land (in hectares) under Agroforestry?
**hh22**________

3.7.2 *Fill the following table about the types of trees used, number of hectares planted, and number of hectares for crop plantation.*

| **Agroforestry Tree** | What is the average number of hectares where this tree has been planted? [enter '0' if not applicable] | | | What is the average number of hectares under crop production? [enter '0' if not applicable] | |
|---|---|---|---|---|---|
| | **1 year** | **2 years** | **3 years** | **Amount during the dry season** | **Amount during rainy season** |
| 1. Sesbania Sesban | | | | | |
| 2.Tephrosia Vogelli | | | | | |
| 3.Grillicidia Sepium | | | | | |
| 4.Acacia Angustisuma | | | | | |
| 5.Leucceana Leucefala | | | | | |

### *3.8 Land holding and use*

3.8.1 How many hectares of land do you or your spouse own?
**hh24**__________

3.8.2 Do you have a land title for any part of land you or your spouse own?
0=No 1=Yes
**hh25**[ ]

3.8.3 Do you rent any land?

0=No → *Go to question 3.8.5* 1=Yes **hh26**[ ]

3.8.4 If yes, how many hectares do you rent?
**hh27**__________

3.8.5 Do you own land that was given to you by someone else?

0=No → *Go to question 3.8.7* 1=Yes **hh28**[ ].

3.8.6 If yes, how many hectares do you rent?
**hh29**__________

3.8.7 Do you rent out land?
0=No → *Go to question 3.8.9* 1=Yes **hh30**[ ].

3.8.8 If yes, how many hectares do you rent?
**hh31**__________

3.8.9 What is the purchase price of land (ZMK)?
**hh32**__________________ per unit **hh33**
(1=acre; 2=hectare; 3=lima)

3.8.10 If yes, what is the rental value of land (ZMK)?
**hh34**__________________ per unit **hh35**
(1=acre; 2=hectare; 3=lima)

3.8.11 What is the total land area used for cropping?
**hh36**_________

3.8.12 From that total (q.3.8.11), how much is used under Agroforestry?

**hh37**____________