SOCIO-ECONOMIC FACTORS INFLUENCING THE ADOPTION OF AGRO-FORESTRY PRACTICES IN NYANJA DIVISION, MUSOMA RURAL DISTRICT, MARA REGION, TANZANIA

BY
ANASTAZIA BHOKE WAMBURA JAMES

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE, MOROGORO, TANZANIA.

2004

ABSTRACT

The recurrent food shortages in the lake shore zone of Musoma rural district led the catholic diocese of Musoma to stimulate the use of agro-forestry practices through Nyanja Agro-forestry Project. Evaluation findings revealed unsatisfactory performance of the project. Factors presented I nclude poor approach for both project design and implementation "top down approach", lack of funds for some of the project activities, limited linkages with other forestry groups and inadequate extension staff and services. A study was carried out in Nyanja division, Musoma rural district, Mara region, with Bukumi, Rusoli, Chitale, Kome and Buanga as target villages from the four Western wards of Nyanja. The main objective of the study was to determine socio-economic factors that influence the adoption of agro-forestry practices in Nyanja division. The study involved social survey. The households were randomly sampled. Two steps were followed, pilot study and actual data collection. In the pilot study 6 households were sampled in each of 5 village while actual data collection involved 40 households in each village, which summed up to 200 households as an overall sample size. Secondary data was collected from various sources whereas primary data was collected using PRA (Participatory Rural Appraisal), household questionnaire and checklist. Data were analysed using content analysis and SPSS (Statistical Package for Social Sciences) program. Findings indicated that, from the year 1991 6% of the population decides to apply agro-forestry technology in the fields every year accounting to a rate of 46.2 trees/ household /ha. This rate with respect to linear regression analysis was evidenced to significantly be influenced by land size and knowledge. Sources of risk, mainly drought, fire incidences, livestock browsing as well as pests and diseases were most frequently mentioned by farmers as constraints to adoption. With an index of 50 trees as adoption at household level, only 33% of respondents were found to have adopted agro-forestry whereby 46.7% cultivable land was under agro forestry. From the logistic regression analysis, the significant factors that were found to influence thc adoption of agro-forestry practices were, labour at $p=0.05$, land size and knowledge at $p< 0.01$. It was therefore concluded that, the main constraint to adoption might be farmers tendency to averse risk resulted from drought, destruction by livestock, pests and diseases as well as fire incidences. The positive perception of economic profitability of the technology by farmers would be as equally important as adequate land, knowledge and labour availability in enhancing the adoption of agro-forestry practices in Nyanja division. Management, research and policy recommendations have been presented.

DECLARATION

I, Anastazia Bhoke Wambura James, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work and has not been submitted for a degree award to any other University.

Signature..AJames................................

Date....27. 10. 2024.....................

COPYRIGHT

ACKNOWLEDGEMENTS

The success of this work has been contributed by several individuals and institutions in the similar way as different parts and systems of the body can function to make life possible. I therefore would like to express my sincere gratitude to Sokoine University of Agriculture for offering a place for M.Sc. degree program in MNRSA while giving the basic guidance for doing research through competent staff during course work. I am grateful to ICRAF through ANAFE for funding the initial activities of this work. I am sincerely indebted to the African Academy of Sciences through AFORNET for awarding me a grant towards the completion of research activities. In particular, I acknowledge the office of Vice Chancellor and that of the Director for Research and Post Graduate Studies of Sokoine University of Agriculture for the administration of the research funds.

I gratefully acknowledge my polite supervisors Dr. J.F. Kessy of the Department of Forest Economics and Dr. E.M.M. Senkondo of the Department of Agricultural Economics and Agribusiness for their strict and friendly guidance, constant encouragement and patience for the whole period of my work. The constructive comments and encouragement from Prof R.C. Ishengoma and G.C. Kajembe of the Faculty of Forestry and Nature Conservation are sincerely appreciated. I am indebted to Mr. D.H. Kitojo of the Department of Wood Utilisation, who assisted me in the identification of some tree species. I would like to express my gratitude to Dr. D.A. Nyange and Mr. A. Mlula of the Department of Agricultural Economics and Agribusiness for devoting their time on giving a detailed clarification concerning adoption models.

My heartfelt thanks should go to Reverend Bishop Justin Samba of The Catholic Diocese of Musoma and his office for the great cooperation that I received during proposal development. The prompt introductory services from the office of Musoma District Commissioner during fieldwork are highly appreciated. I thank Miss Rose Marijani of Vi AFP for her useful contribution to this work.

I owe special gratitude to Community Development Officer, Mr. D. Misana, ward and village leaders, Mr. R. Malima, Mr. B. Sonenga, Mr. P. Mgaya and E. Sogoto, Foresters, Miss M. Chamba, Z. Werema and R. Muya as well as Extension Officers, Mr. M. Salige and Mr. M. Masatu. They played the important role of facilitating field data availability. I particularly thank Mr. G. Donald of Ukiriguru Research Institute for guiding PRA sessions. My young brother, Benedict managed the timely continuation of activities by carefully driving throughout the period of field data collection especially during rains. I highly appreciate his participation. Mrs C. Kilasara of SUA and Mr. W. Mazaba of TRA, Mwanza instantly solved all computer software problems. I thank them for their kindness that is difficult to repay.

It is not easy to exhaust the list of the rest of contributors, colleagues, friends and relatives inclusively but I remain grateful to all. I would lastly like to mention and specially thank my lovely family, Mr. L. Paul (my beloved husband) for patience and the support that can not be measured, my children, Rhobi, Roche and Rila for prayers, encouragement and maintaining my peace of mind and harmony as always as they could. I thank my young sisters, Winy, Wang'enyi and Brother Willy without forgetting my beloved father, Mr. J. Wambura who is my first academic teacher.

DEDICATIONS

This work is dedicated to my beloved father, Mr. James Wambura and my late mother, Mrs. Cecilia Wambura for their good upbringing with the spirit of struggling for the best. May almighty God rest my mother's soul in Eternal Peace, AMEN.

TABLE OF CONTENTS

ABSTRACT ... ii
DECLARATION ... iv
COPYRIGHT ... v
ACKNOWLEDGEMENTS ... vi
DEDICATIONS ... viii
TABLE OF CONTENTS ... ix
LIST OF TABLES ... xiii
LIST OF FIGURES ... xiv
LIST OF APPENDICES ... xv
LIST OF ACRONYMS AND ABBREVIATIONS ... xvi
CHAPTER ONE ... 1
1.0 INTRODUCTION ... 1
1.1 Background Information ... 1
1.2 Problem Statement and Justification ... 2
1.3 Objectives ... 3
1.3.1 General Objective ... 3
1.3.2 Specific Objectives ... 4
1.4 Hypotheses ... 5
CHAPTER TWO ... 6
2.0 LITERATURE REVIEW ... 6
2.1 Concept of Agro-forestry Practices ... 6
2.2 Classification of Agro-forestry technologies ... 7
2.3 Functions of Agro-forestry Systems ... 9

2.4 Socio-economic factors influencing the adoption of agricultural and conservation technologies 11
2.4.1 Risk and economic profitability 12
2.4.2 Labour requirement 14
2.4.3 Technology characteristics 14
2.4.4 Capital 15
2.4.5 Farmer characteristics 15
2.4.6 Farm size 17
2.5 Adoption models 18
2.6 Problems with the lakeshore zone and agro-forestry related interventions in Musoma Rural district 20
2.6.1 Majita Migrants Agriculture Project (MMAP) 21
2.6.2 Nyanja Agro-forestry Project (NAP) 21
2.6.3 VI Agro-forestry Project (VI AFP) 23
2.7 Conceptual framework 24
CHAPTER THREE 26
3.0 METHODOLOGY 26
3.1 Description of the Study Area 26
3.1.1 Geographical Location and administrative units 26
3.1.2 Area, population and ethnic groups 27
3.1.3 Altitude and climate 31
3.1.4 Soils and natural vegetation 31
3.1.5 Economic activities, water and forests 32
3.2 Research design and sampling procedures 33
3.3 Pre-testing 34
3.4 Data collection 36

3.4.1 Secondary data 36

3.4.2 Primary data 36

3.5 Data Analysis 37

CHAPTER FOUR 39

4.0 RESULTS AND DISCUSSION 39

4.1 General description of farm households 39

4.1.1 Total population and resources 39

4.1.2 Characteristics of the sampled households 41

4.2 Household resources and characteristics 45

4.2.1 Land holdings 46

4.2.2 Crops 49

4.2.3 Agro-forestry 53

4.2.4 Livestock 60

4.2.5 Farm labour 61

4.2.6 Water 61

4.2.7 Off farm income 62

4.3 The rate and intensity of adoption of agro-forestry practices 63

4.3.1 The rate of adoption 63

4.3.2 The intensity of adoption 67

4.4 Socio-economic factors influencing the adoption of agro-forestry practices 69

4.5 Options for enhancing the adoption of agro-forestry: farmers' participation 72

CHAPTER FIVE 77

5.0 CONCLUSIONS AND RECOMMENDATIONS 77

5.1 Conclusions 77

5.2 Recommendations 79

5.2.1 Management recommendations 79

5.2.2 Research recommendation 80

5.2.3 Policy recommendations 81

REFERENCES 82

APPENDICES 88

LIST OF TABLES

Table 1: Forest Resources (Hectares) in Musoma Rural district 33

Table 2: Descriptive statistics for the stratified pilot sample..35

Table 3: Descriptive statistics for stratified major survey 37

Table 4: Population and resources in the study area 40

Table 5: Comparison of Mara region with other highly populated regions in household size..40

Table 6: Characteristics of sample population by village...42

Table 7: Background characteristics of respondents by village 43

Table 8: Description of the age groups of respondents in the study area 44

Table 9: Household resources and characteristics by village.......................................45

Table 10: Types of crops cultivated in Nyanja division 50

Table 11: Average annual income (Tshs) from household resources during the year 2000 to 2002 52

Table 12: Structure of agro-forestry in the study area..54

Table 13: Abundance of the promoted agro-forestry tree species (%respondents and tree species)..57

Table 14: Farmers' identification of constraints on adoption 67

Table 15: The intensity of adoption (% of respondents) by village 68

Table 16: Socio-economic factors influencing the adoption of agro-forestry practices in nyanja division (n=187) 70

LIST OF FIGURES

Figure 1: Some of the determinants of adoption (A conceptual framework) 25

Figure 2: Location of Mara region in Tanzania 28

Figure 3: Location of Nyanja division in Musoma Rural district, Mara region 29

Figure 4: Location of study villages in Nyanja division 30

Figure 5: Bare hills as the source of fuel wood 46

Figure 6: Soil characteristics in the most parts of Nyanja division 47

Figure 7: Land acquisition system presented as percent respondents 49

Figure 8: Average earnings from household resources 53

Figure 9: Main composition of tree home gardens in the study area 56

Figure 10: *Cedrella odorata* species at the young stage in the distant fields 58

Figure 11: Mango tree retained as household food reserve 59

Figure 12: Various sources of non farm income 63

Figure 13: The trend of the adoption of agro-forestry in the study area. 65

Figure 14: *Melia azedarach* species ready for utilization as fuel wood 75

LIST OF APPENDICES

Appendix 1: Household questionnaire form 88

Appendix 2: Checklist 97

Appendix 3: Calculations for the determination of actual sample size 101

Appendix 4: Agro-forestry tree species in % respondents and species planted/ retained in the study area 103

Appendix 5: Frequency distribution table for the date when a farmer started tree planting (n=147) 106

Appendix 6: The results of linear regression analysis 107

Appendix 7: The dependence of adoption on village 108

Appendix 8: Relationship between land size, age and adoption by village 109

Appendix 9:The results of Logistic Regression analysis 115

LIST OF ACRONYMS AND ABBREVIATIONS

AFORNET	African Forestry Research Network
ANAFE	Afican Network for Agro-forestry Education
C	Centigrade
CE/T	Community Education and Training
CRS	Catholic Relief Cervices
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization
Hh	Household
HQ	Headquarters
ICRAF	International Centre for Research in Agro-forestry
IFAD	International Food and Agriculture Development
Km	Kilometres
LPM	Linear Probability Model
MMAP	Majita Migrants Agriculture Project
MNRSA	Management of Natural Resources for Sustianable Agriculture
NAP	Nyanja Agro-forestry Project
PRA	Participatory Rural Appraisal
SUA	Sokoine University of Agriculture
S.E.	Standard Error
STD	Standard deviation
VI AFP	Vi Agro-forestry Project
WFP	Word Food Program
Yrs	Years

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

In many agricultural based developing countries one form of environmental degradation is soil nutrient depletion accompanied by loss of food production potential (Shiferaw *et al.*, 1998). Similar to other parts of Tanzania, deforestation in Mara region has been one of the major causes of environmental degradation leading to recurrent food shortages especially in Musoma Rural District. In responding to this situation, Caritas Tanzania in collaboration with the World Food Program (WFP) for a long time had been concerned with food aid distribution to food deficit areas in the region using the Diocese of Musoma as an agent.

Deforestation being one of the root causes of food shortage, the Diocese of Musoma eventually felt that there was a need to stimulate the use of agro-forestry practices through Nyanja Agro-forestry Project, which was implemented in 1991 in Nyanja division, Musoma Rural District. The idea lies in the fact that soil and water management provide the base for food production. These could be improved through establishment of shelterbelts, windbreaks and scattered trees, and through soil enrichment. The Nyanja Agro-forestry Project had the goal of conserving and improving soil fertility, increasing productivity of the land, and providing a variety of fruits, wood and forest based products. The project covered a total of five target villages aiming at such components as farmers training through study tours and exchange visits, establishment of village tree nurseries, as well as selling of tree seedlings to village members. Every household was encouraged to plant 25 trees yearly. Four of the trees would be fruit bearing species in the home compound, two multi-purpose variety also planted in the home compound, and, nineteen timber/firewood trees on the farms as boundary markers or scattered in the farms. On the other hand through agro-forestry, climatic conditions of the area could be improved, as argued by FAO (1993) that, there is a link between tropical forests and the stability of local, and possibly regional and global climatic conditions. According to Catholic Relief Services-Kenya (1995) the general performance of Nyanja Agro-forestry Project in terms of adoption was not convincing.

Adoption at the farm level, as defined by Yaron *et al.* (1992), is the realization of a farmer's decision to apply a new technology in his or her production process. Final adoption according to Feder *et al.* (1985) is the farmer's degree of using a new technology in long run equilibrium of the farm.

Factors explaining the level of adoption of agricultural and conservation technologies according to Yaron *et al.* (1992) and Boahene (1998), include capital/credit, land, labour, extension services, attractive producer prices and risk. FAO (1999) suggests that risk may influence technological innovation in that the rural poor choose activities and techniques of production that keep income variations to a minimum. That is, the poor will resist technological innovations that raise the mean and variability of income at the same time. Generally risk takers are more likely to adopt than risk averters.

1.2 Problem Statement and Justification

The adoption of innovations in agriculture has been studied intensively since Griliches (1957) pioneering work on adoption of hybrid corn in the U.S.A. (Ghadim and Pannel, 1999). Adoption research reveal contradicting results regarding the importance and influence of any given variable. This means that factors influencing adoption of agricultural or conservation technologies are different depending on farmers' characteristics, the nature of technology and a number of other social economic factors. Thus it is not possible to extrapolate results from one location to another, hence the need for location specific studies.

The results of evaluation done in 1995 by CRS-Kenya and the Diocese of Musoma on the performance of Nyanja Agro-forestry Project (NAP) indicated that adoption was generally unsatisfactory during the four years of project implementation. However a detailed assessment of factors that influenced the adoption of agro-forestry practices in the project area was not conducted.

It is anticipated that the research findings from this study can enable the stakeholders to understand in detail why the performance of Nyanja Agro-forestry Project was poor. The findings will also contribute to additional knowledge on factors influencing adoption of technologies as a partial fulfilment for the need for location specific studies.

1.3 Objectives

1.3.1 General Objective

The main objective of the study is to determine socio-economic factors that influence the adoption of agro-forestry practices in Nyanja division.

1.3.2 Specific Objectives

(i) To determine the rate and intensity of adoption of agro-forestry practices in Nyanja division by the use of descriptive statistics.

a. The rate of adoption expresses the number of new agro-forestry participants per year as well as the number of trees planted per household per hector.

b. The intensity of adoption is simply the estimated percentage of those who have adopted agro-forestry practices and the percentage of land used for agro-forestry out of the cultivable land owned by the households.

(ii) To determine socio-economic factors influencing the adoption of agro-forestry practices in the study area. These include capital, perceived economic profitability, farm size, labour, age of the farmer, knowledge, level of eduction, extension services and technology characteristics. Some of these factors for instance farm size and age are linked to risk aversion.

(iii) To find out how the adoption of agro-forestry practices can be enhanced.

To accomplish the above objectives the following research questions were formulated:

1. What is the structure and composition of agro-forestry in the study area?
2. What is the rate and intensity of adoption of agro-forestry practices in Nyanja division?
3. How do farmers perceive deforestation?
4. What are the farmers' perceptions on technological feasibility?
5. What do farmers benefit from agro-forestry?
6. Do the tree species planted in farms/field serve soil-improving purposes?

7. What socio-economic factors are influencing the adoption of agro-forestry practices in Nyanja division?
8. What is the relative importance of each factor?
9. What should be done to enhance the adoption of agro-forestry practices?

1.4 Hypotheses

The null hypothesis tested is:

H_0: Socio-economic factors are not influencing the adoption of agro-forestry practices.

The alternative hypothesis is:

H_1: Socio-economic factors are influencing the adoption of agro-forestry practices.

CHAPTER TWO

2.0 LITERATURE REVIEW

Agro-forestry is a widespread practice in Tropical Africa aiming at solving a large body of both environmental and socio-economic problems of the rural and urban population. This chapter provides an overview on the concept, classification and functions of agro-forestry. Problems associated with the lakeshore zone have been described and agro-forestry related interventions in Musoma Rural district have also been presented. Since in any intervention constraints are inevitable, this chapter has attempted to discuss some of the socio-economic factors influencing the adoption of conservation technologies including agro-forestry. Some of the adoption models and the conceptual framework of the study have been presented in this chapter.

2.1 Concept of Agro-forestry Practices

Owusu (1990), Jason (1991), Heathcote (1992) and Nair (1993) have described agro-forestry, throughout the world, in its history, as the practice to cultivate tree species and agricultural crops in intimate combination, and that the historic development of these agro-forestry practices in different parts of the world is traced differently. Also the practices are wide spread and extremely varied.

Literature such as Altieri (1991), Michon and Mary (1994), as well as Fernandes *et al.* (1984), O'Kting'ati (1985) and Rugalema *et al.* (1994) provide examples, which indicate the wide geographical coverage of the agro-forestry practices and their early origin in Latin America, Kenya, Indonesia and Tanzania respectively.

Cases of agro-forestry practices have been reported where population pressure had reached a high peak as peasants resort to intensive use of land to sustain the needs of the growing populations on limited land (O'Kting'ati, 1985). According to Nair (1993), various forms of home-gardens, tree plantation crop combinations and multilayer tree gardens are common in such regions.

Numerous agro-forestry systems and practices exist in tropical highlands of the world. Balton (1984) reported about traditional agro-forestry practices based on *Feidherbia albida* and other multipurpose trees as practiced by sedentary people on the lower slopes and highlands of Jebel Marta Massif, Sudan. This practice has sustained a densely settled population over centuries.

Similarly, Caveness and Kurtz (1993) and Rugalema *et al.* (1994) describe agro-forestry practices existing in Senegal and Bukoba Tanzania, as live fences and wind breaks as well as home gardens respectively. The Chagga multi-storeyed cropping system on Mount Kilimanjaro (Fernandes *et al.*, 1984), and North South highland regions of Tanzania, (Mnkeni, 1992) are all agro-forestry practices.

2.2 Classification of Agro-forestry technologies

ICRAF (2002) provides classification criteria according to components, structure, time and functions as follows:

- Looking at components, a distinction can be made between agrosilvocultural (crops with trees), silvopastoral (Trees with livestock) and agrosilvopastoral (Crops, trees and livestock) systems, practices or technologies.

- Structural criteria indicate how the tree component is spatially present in the farming landscape (example. linear arrangements, scattered trees, multistrata home gardens, boundary planting etc).
- Temporal criteria differentiate technologies using time of presence of individual components. Simultaneous technologies are those where trees and crops grow at the same time and in close enough proximity for interactions to occur (example. hedgerow intercropping, boundary planting, home gardens etc). In sequential technologies, the maximum growth rates on the crop and tree components occur at different times even though both components may have been planted at the same time and are in close proximity (e.g. shifting cultivation, improved fallows, taungya etc)
- Functional criteria distinguish technologies based upon the main role of the tree component, which can be production (fuel wood, fodder, fruits etc) and/or service (e.g. windbreak, erosion control and soil fertility).

Combining two or three of these criteria and considering certain other bio-physical and/or socio-economic factors has led to a variety of possible classifications of agro forestry systems, practices and technologies (ICRAF 2002). These include:

(a) Crops under tree cover

Scattered trees in cropland, plantation crop combinations, shade trees in cropland fall under this practice.

(b) Animal production under tree cover

The practice includes grazing under forest or scattered trees, pasture production under forest or scattered trees, animal production in woodland.

(c) Agro forests

These are tree home gardens, village agro forests, woodlots and other block planting of trees on farmland.

(d) Agro-forestry technologies in a linear arrangement

These include windbreaks and shelterbelts, boundary planting, live hedges, living fences, woody strips and tree hedges, soil conservation and contour hedges, hedgerow intercropping (alley cropping), alley farming.

(e)Sequential agro-forestry technologies

Shifting cultivation, improved trees fallows, taungya, relay intercropping are classified as sequential agro-forestry.

(f)Trees with fisheries (aqua forestry).

(g)Trees with insects (entomoforestry

2.3 Functions of Agro-forestry Systems

According to Nair (1993), the four fundamental attributes of all agro-forestry systems are productive, service, protective and socio-economic functions.

(i) Productive Function

Productive role played by agro-forestry includes food, fruits, fuel wood, animal forage/fodder, herbs, small diameter craft wood and timber. The most typical system that performs productive function is home gardens since they include different types of tree species, shrubs, herbaceous crops and animals.

(ii) Service Functions

The most important service function is maintenance of soil fertility. Trees used in agro-forestry systems provide services such as improvement of microclimate and control of crop pests. The major effects of trees on soil fertility are control of erosion, maintenance of soil organic matter and physical properties, nitrogen fixation, improved uptake of nutrients and nutrient recycling (FAO, 1991).

Agro-forestry systems that incorporate animals with tree crops can enhance important cycles of nature such as nutrient cycling and balancing of insect populations while reducing energy intensive management techniques. If planned and managed properly, appropriate kinds of animals can be key components in sustainable farming systems. The key is to integrate the natural needs, behaviors, and products of animals with the environment provided by the agro-forestry system in a way that maximizes the benefits to the animals and to the system as a whole.

According to Pell (1999), animals can perform many beneficial functions when integrated into an agro-forestry system. Some services and products of animals for agro-forestry include: weed maintenance, insect control, cleaning of fallen fruit/nuts and spreading nutrients in the form of manure.

(iii) Protective Functions

Agro-forestry systems protect and improve the quality of natural resources including soil, water, vegetation and wildlife and is also used to substitute for the destructive use of special environments such as riverine forests, hill slopes and fragile rangeland (Rocheleau *et al.*, 1988). Vegetative cover provided by the trees, crops and grasses facilitates the protective role of agro-forestry systems by preventing soil erosion.

(iv) Socio-economic Function

A study conducted by ICRAF (1997) revealed that about 24% of the world's population both rural and urban or 1.5 billion people in developing countries of Asia, Africa and

Latin America depend largely on agro-forestry products and services for their livelihood.

Rural dependency on agro-forestry is primarily reliance on trees for fuel wood for cooking and fodder for feeding backyard animals. Rural dependency on agro-forestry increases with increasing poverty. The dependency is highest in sub-Saharan Africa, next in tropical Latin America and least in Asia (ICRAF, 1997).

2.4 Socio-economic factors influencing the adoption of agricultural and conservation technologies

Different factors influence adoption differently. In their analysis, Kessy and O'Kting'ati (1994) found that the extent of tree planting and fodder grass cultivation was positively correlated with size of farm holdings, size of household and total number of livestock stall fed by the household. The same was negatively correlated with age of the head of the household, walking distance for fodder and fuel wood collection, which implies less time available for tree planting. Cary and Wilkinson (1997) identified five factors, which contribute to more generalized conservation behavior by rural landholders. They include:

- Recognition of an environmental problem
- A perception that an available solution is technically feasible
- The technical solution is perceived to be economically profitable
- The presence of psychological motivations to act
- The scale of farm operation

However Yaron *et al.* (1992) argue that, no simple, unqualified extrapolation from one farming system to another is possible due to the differences in factor endowments and technology and farmer's characteristics. For example, effect of farm size or level of education cannot be compared between different regions, say Argentina and Egypt. This underscores the need of numerous adoption studies to be done within regions.

In regard to agro-forestry practices, on one hand adoption is expected to hold potential for slowing deforestation and environmental decline whereby production of wood for fuel and construction, fodder for animals as well as soil nutrient and erosion control associated with increased productivity are potential benefits. On the other hand non adoption may lead to increased deforestation and environmental decline, which are the contributing factors for decline in productivity resulting to food shortage.

In the assessment of local adoption of new forestry technologies, Amacher *et al.* (1993) suggested that, forest technology adoption is similar to household adoption of other technologies.

2.4.1 Risk and economic profitability

Risk perception has widely been reported as adoption factor. According to Senkondo (2000), risk attitude is the farmer's evaluation of the desirability of what happens when he or she adopts a practice, and, risk perception is a mental interpretation of the physical sensations produced by an external stimulus. Despite the fact that measuring risk is inherently difficult, adoption is often associated with greater risk. Risk aversion is likely to be associated negatively with adoption, and for any level of farmer's risk aversion, the likelihood of adoption is related positively to the degree of performance information about the new technology (Yaron *et al.,* 1992). Thus, practitioners should be worried if they do not have information about farmer's perceptions of consequences from the adoption of recommended technologies and about yield performance in farmers' fields (Walker, 1981).

Caveness and Kurtz (1993) suggest that, producers with higher variation in production yields and production value most likely assume risk of adoption of agro-forestry. Since higher variation may indicate that the farmers is accustomed to uncertainty, it can be assumed that he/she would be willing to take on risk in an attempt to stabilize his/her enterprise returns. Conversely, producers with lower variation in production value/yields may be assumed to be less likely to risk agro-forestry adoption. This is because felt wealth is low, variance of production is low and the producer is unwilling and /or unable to absorb potential failure.

Caveness and Kurtz (1993), in their study of agro-forestry adoption and risk perception, concluded that, non-adopters would appear less willing to take risk than adopters. This finding correspond with the conclusion made by Amacher *et al.* (1993) that, one of the characteristics explaining adoption is household willingness to accept the risk attached to the uncertain gain from adoption of forest technology. Similarly Senkondo *et al.* (1998) suggests that, improving farmers' risk taking capacity would enhance adoption of Rainwater harvesting techniques.

Cary and Wilkinson (1997) in their study of influence of perceived profitability on conservation, reported that, the best way to increase the use of conservation practices to overcome land degradation, where there are potential productivity gains substantially internalized for individual farm properties, will be to ensure the practices are economically profitable.

2.4.2 Labour requirement

Different adoption studies (Kalineza *et al.*, 2000; Yaron *et al.*, 1992; Senkondo *et al.*, 1998; Lapar and Pandey, 1999) show that, labour requirement has an influence in adoption of soil conservation practices. New technologies are sometimes labour intensive. Families with little number of their members working in the farm are likely to be non-adopters because labour required to manage a project is sometimes unavailable.

Ghadim and Pannell (1999) highlight that availability of labour is likely to influence the gross margin of the innovation through its effect on the yield or output of the product. Also the additional working family members or trusted employees provide the opportunity for the farm to develop the technical know how required to try a small area of a new crop.

2.4.3 Technology characteristics

Batz *et al.* (1999) reported technology characteristics to influence the rate and speed of adoption. Farmers can evaluate the new technologies available and compare them with their traditional alternatives. This reveals that the greater the tendency to adopt a new technology, the greater its relative utility, which in turn lead to a higher rate and speed of adoption.

Technology characteristics are explained by management complexity, risk reduction and relative investment requirement. The important technology characteristic for farmers is that which reduces risks relative to the traditional technologies and/or do not increase management complexity of the system considerably. In the Rain Water Harvesting study, Senkondo *et al.* (1998) found that, farmers perception in rainwater harvesting technology as increasing crop yield was positively and significantly related to the intensity of adoption of the technique.

2.4.4 Capital

To the extent that liquidity is a constraint to adoption, non-farm income will have a positive effect on adoption by relaxing this constraint (Lapar and Pandey, 1999). Ghadim and Pannell (1999) found equity as a measure of wealth, to positively influence the initial scale of a trial of an innovation. This is because wealth allows the farmer to invest a relatively smaller proposition of their wealth to venture into an uncertain enterprise. The impact of this factor may be partially through its relaxation of financial constraints, as well as through decreasing risk aversion with increasing wealth (Anderson *et al.,* 1977 cited by Ghadim and Pannell, 1999).

2.4.5 Farmer characteristics

(i)Knowledge, education level and extension services

Empirical evidence (Senkondo *et al.*, 1998: Kalineza *et al.*, 2000) suggests that farmers who are knowledgeable in a technology are expected to adopt the techniques compared with those who are not knowledgeable. According to Lapar and Pandey (1999), adoption of soil conservation in Philippine could be hypothesized as positively correlated with the farmer's education level. Conversely, Kalineza *et al.* (2000) reported that education was not a significant determinant of the adoption of soil conservation practices in Tanzania.

However, according to Yaron *et al.* (1992), the relationship between adoption and education is positive up to a certain level and then becomes negative. A higher level of experience may diminish the likelihood to adopt since the farmers involvement in farm work may be important as well. In addition, innovativeness is influenced by extension, but not necessarily education. This means that farmers with elementary school education are capable of adopting innovation and complex technology if proper extension services are provided.

(ii) Age of the farmer

The effect of age of the farmer on adoption decision can be taken as a composite of the effects of farming experience and planning horizon (Lapar and Pandey, 1999). While longer farming experience as equated with older farmers is expected to have a positive effect on adoption, younger farmers, on the other hand, may have longer planning horizons and, hence, may be more likely to invest in conservation. Ghadim and Panell (1999) suggest that, age and experience of the farmer, as indicated by the number of years that the farmer has been farming in the region, is likely to have a range of influences on adoption. The farmer's previous experience with other innovations may have been either positive or negative, and this will likely influence his or her perception of the gross margin of the innovation.

Age may influence risk aversion, with the traditional viewing being that older farmers are more risk averse. Shiferaw and Holden (1998) point out that younger households are more likely to adopt conservation practices once they perceive the problem than old peasants Again, while the above literature suggest lower adoption with increase in age, Kalineza *et al.* (2000) found that, age was not a significant determinant of adoption of soil conservation practices. These differences have a positive implication on the previous literature suggestion that no simple extrapolation from one farming system to another is possible.

2.4.6 Farm size

Literature suggests that effect of farm size on adoption depends on type of technology. That is, for some practices small scale is associated with proportionally higher incidence of conservation behavior while other conservation practices requiring expensive machinery and equipment may be precluded on smaller scale properties. For example, Cary and Wilkinson (1997), in their study, found that scale of farm operation did not influence the decision to sow *phalaris* pasture, reflecting scale economies associated with access to and use of machinery for pasture sowing. According to Yaron *et al.* (1992), small farms are suitable for labour intensive technologies as they use relatively more family labour, which has a low alternative cost.

The above body of literature has attempted to indicate that, most conservation technologies have some constraints to adoption and some of these factors example capital are constant while some vary with type of technology and farmer characteristics. However, there is a research gap on factors influencing the adoption of agro-forestry practices.

2.5 Adoption Models

Cary and Wilkinson (1997) pointed out that well-tested models for predicting conservation behaviour of rural landholders are relatively few. Sinden and King (1990) used a three-stage model of conservation practices to investigate the factors promoting soil conservation at each stage in the process of adoption of land conservation practices (Cary and Wilkinson 1997). The model-involved perception of land condition, recognition of a problem worth trying to resolve and decision to resolve a problem. According to Cary and Wilkinson (1997), the limitation with this model is that it is difficult to identify and distinguish perception from recognition of a problem due to the fact that these two processes are likely to be interrelated rather than discrete and sequential. However the decision stage could be recognized through observed behaviour. Cary and Wilkinson (1997) modified Sinden and King (1990) model into 'use not-use' decision model conceptualized as:

$$P_i = 1/\left[1 + e^{-f(r, z, t, o, s)}\right]$$

Where:

P_i = the probability of using a particular practice.

r = recognition of an environmental problem on the farm.

z = a vector of variables measuring perceived profitability of the conservation practice.

t = a vector of variables measuring perceived technical feasibility of the conservation practice.

o = environmental orientation of decision maker.

s = scale of farm operation.

As suggested by Cary and Wilkinson (1997), the potential limitation in using the above model is that the behavior as an outcome is likely to influence the supposedly antecedent predictor variables. Since both are measured at the same time, it is difficult to be sure, which has caused which, or whether both have been caused by something else. To minimize the effect, a pretest post test design has to be used, that is, measuring some predictor variables e.g. perception and orientation at time 1 prior to measuring an outcome at time 2.

According to Jere (1995), the relationship between adoption and several independent variables can be depicted as:

$P = f(x_i)$

Where:

P = observed technology adoption

x_i = vector of exogenous variable e.g. total crop hectares available, household characteristics, fixed assets etc.

Linear probability model (LPM), the logit model and probit model approaches can be used to estimate such relationships (Guajarati, 1988 in Jere, 1995).

The linear probability model takes the form:

$Y_i = \alpha + \beta x_i + E_i$

Where:

x_i = value of attribute e.g. income

Y_i = 1 if first option is chosen, 0 if otherwise

E_i = independently distributed random variable with zero mean

The problem pointed out by Jere (1995) is that in LPM the variance term is not constant for all observations and this results in loss of efficiency but does not result in either biased or inconsistence parameter estimates.

Probit model is commonly used and it is associated with the cumulative normal probability function expressed as:

$Z_i = \alpha + \beta x_i$

Where:

Z_i = existing index (continuous variable which is normally distributed).

x_i = explanatory variable.

The problem with probit model is that it generally involves non-linear estimation because the cumulative normal transformation is non-linear, and thus Ordinary Least Squares (OLS) cannot be generally applied to estimate the model Jere (1995).

The logit framework which follows logistic distribution function is also most commonly used, and is presented as:

$\text{Ln } w = b_o + \beta_i x_i + E$

Where:

$\text{Ln } w = p^*/(1-p^*)$ = log of odds ratio in favour of adopting a technology

x_i = (a vector of exogenous variable)

2.6 Problems with the Lakeshore Zone and Agro-forestry Related Interventions in Musoma Rural District

(i) The lakeshore zone is confronted by several constraints including:

(ii) Increasing population pressure

(iii) Declined soil fertility

(iv) Low moisture holding capacity of soils

(v) Few trees

(vi) Infestation of striga weed on cereals

(vii) Slow disappearance of sorghum, finger millet and bull rush millet from the original food supply system

2.6.1 Majita Migrants Agriculture Project (MMAP)

The Diocese of Musoma reported that, it had agreed to technically support the proposed MMAP activities with financial assistance from CRS.

This support would be in place in the year 1994 if the government provided social services to some locations in Bugwema ward (located in Nyanja division as can be seen in figure 3.3) where people from overpopulated areas were expected to migrate. According to the project proposal, three hundred households had to migrate from the over-populated lakeshore zone to new sparsely populated productive locations in Bugwema ward where each migrant household would have access to 12 acres.
The proposed activities in MMAP included farmers training in sustainable agricultural techniques as well as provision of oxen and ox ploughs to assist in animal traction farming. However due to lack of basic social services such as water, health and education, only a few families could migrate to the proposed area and hence a constraint to project implementation.

2.6.2 Nyanja Agro-forestry Project (NAP)

The Nyanja Agro-forestry Project started in 1991 and was designed to promote agro-forestry practices in Nyanja Division in order to improve food security and availability of wood and forest based products. According to the Diocese of Musoma (undated), the specific objectives of the above mentioned project were:

(i) To raise an awareness and understanding of the benefits of agro-forestry amongst farmers.

(ii) To train 12 farmers, 12 schoolteachers and 54 pupils in tree nursery technology.

(iii) To train 5 Village Forest Committee members of each village in project management and book keeping skills.

(iv) To encourage every household and 10 agro-forestry model farmers in each village under project to plant 25 trees yearly and to establish hedgerows of 252 plants by the end of the project.

The Nyaja Agro-forestry Project was implemented for four years after which an evaluation followed in 1995.

Evaluation findings

CRS-Kenya (1995) presented the following overall findings for the evaluation of Nyanja Agro-forestry Project.

- The community did not seem to have involved in the project design, evidenced by little participation outside nursery attendants and model farmers. This illustrated an over reliance and almost total dependence on existing village government structures, which did not promote community ownership or spread skills and information about the potential benefits of tree planting.
- The project primarily promoted fruit and wood/timber trees, mainly *Khaya anthotheca*, *Melia azedarach* and *Eucaliptus* species, which would have a clearly visible economic benefit. Agro-forestry trees, which improve soil fertility, were not promoted.

- The project promoted the use of artificial pesticides instead of natural/biological agents and this would increase dependence on inputs from the diocese.
- The yearly provision of nursery inputs such as seeds, tools, plastic bags etc undermined financial self-sustainability of the nurseries.
- Project activities were often slowed due to lack of funds.
- The Nyanja agro-forestry project had no linkages with other forestry groups and organizations working in the area and there had been no assistant from government extension agents to provide additional technical support.
- The overall approach was 'top down'. The needs were not identified by the community and the project was not implemented by the community, but by the village council and their chosen village forest committee.
- Only one goal was reached, that of identifying at least 10 model farmers in each of the five villages. Other objectives were not reached due to the overall approach, which did not promote real community ownership of project activities.

2.6.3 VI Agro-forestry Project (VI AFP)

As reported by CE/T Unit Musoma (2002) VI A gro-forestry P roject started in Mara region in 1994 and spread through Nyanja division in 1999 to date and it is funded by Vi foundation based in Sweden.

The goal of the project according to CE/T Unit Musoma (2002) is to contribute towards improving the livelihood of small-scale farmers owning an average of 5 acres of land living in Mara region in 5-10 years. Project specific objectives are:

(i) To increase fuel wood availability in 1-5 years,

(ii) To increase food and nutritional security in 1-5 years.

The target groups for VI Agro-forestry Project are small-scale farmers with an average of 5 acres of land who mostly depend on it for subsistence and mainly use family labour for production. The main activities include establishment of household tree nurseries and encourage each household to plant 20 trees at homes and in farms every year, provision of farmer tours and seminars in agro-forestry practices and in the use of natural pest sides.

2.7 Conceptual framework

According to Nowak (1987), models of conservation behaviour focus on diffusion perspective of technology adoption and those based on the influence of attitudinal variables as predictors of behaviour. For adoption the two sides are involved, that is, the stakeholders, who normally stimulate the use of technologies, and farmers who actually may be considered as adopters or non-adopters. While the former mainly have non-economic objectives, the later may have both economic and non-economic objectives. Due to variability in farmers' characteristics between different farming systems or locations the determinants for decision to use or not to use a particular technology also differ between these systems or locations. Thus, aspects such as household resources and characteristics, farm orientation, sociological factors, farming systems, technology characteristics, institutional and policy factors are to be put into consideration by both the stakeholders and researcher (Figure 1).

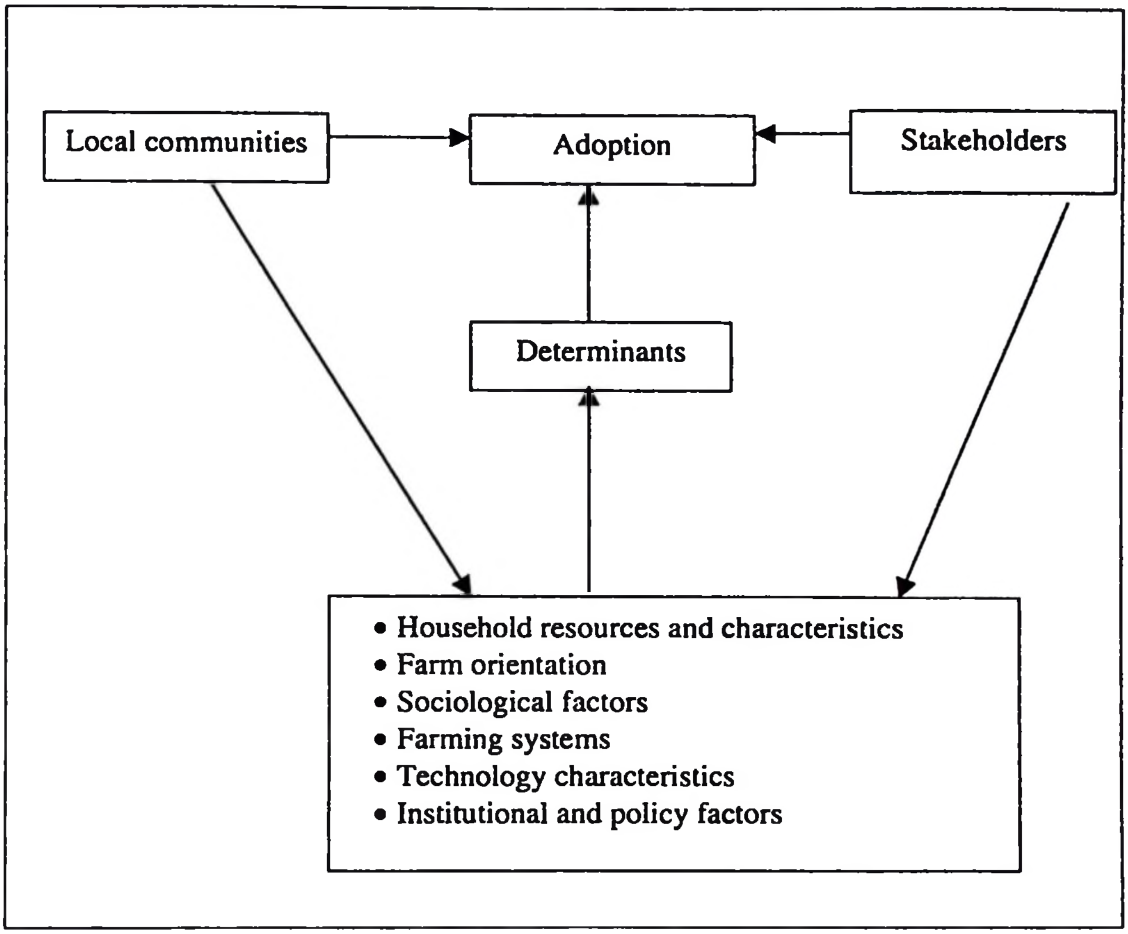


Figure 1: Some of the determinants of adoption (A conceptual framework)

CHAPTER THREE

3.0 METHODOLOGY

This chapter presents the methodology that was followed to come up with research results. The chapter describes the study area, research design and sampling as well as data collection and analysis procedures. The methods and procedures suited both the general and specific objectives of the study.

3.1 Description of the Study Area

3.1.1 Geographical Location and administrative units

Musoma rural district is one of the five districts of Mara region. Mara region is located in the Northern part of Tanzania (Figure 2) at an approximately between latitude 1° and 2° 31′ South of the Equator and between longitude 33° 10′ and 35° 15′ East of Greenwich. The region is bordered by the Republic of Kenya to the North, Kagera Region to the West, Mwanza and Shinyanga regions to the South and Arusha to the East. It is also flanked by Lake Victoria on the Northern-West (Anon, undated) Musoma Rural district lies approximately between Latitude 1° 15′ and 1° 45′ south of the Equator and between longitude 33°15′ and 34°15′ East of Greenwich meridian. It is bordered by lake Victoria to the West, Bunda district to the South, Serengeti district to the East and Tarime District to the North (Figure 3).

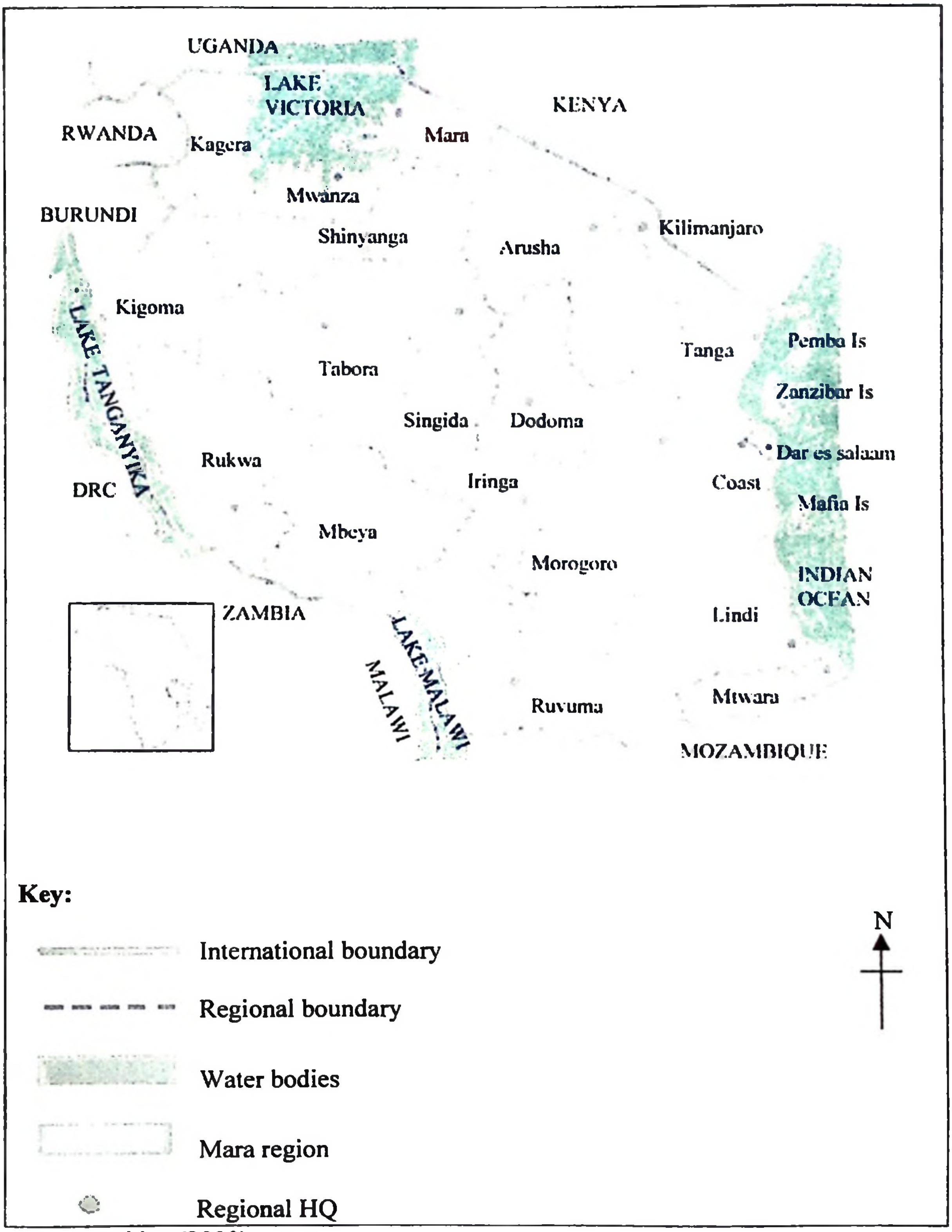
The district is divided into three divisions namely Nyanja, Makongoro and Kiagata. Musoma Rural district had 26 wards divided into 103 villages by 1995. Nyanja division itself has 12 wards and these are Bukumi, Bukima, Bwasi, Bugwema, Kiriba, Makojo, Murangi, Mugango, Nyamurandirira, Nyambono, Suguti and Tegeruka. The division is in the Southwestern part of Musoma while the five study villages are located in the four western wards (Figure 4) at approximately 80 - 110 km from Musoma town.

3.1.2 Area, population and ethnic groups

According to Anon (undated), Musoma rural district has the following data for area and population.

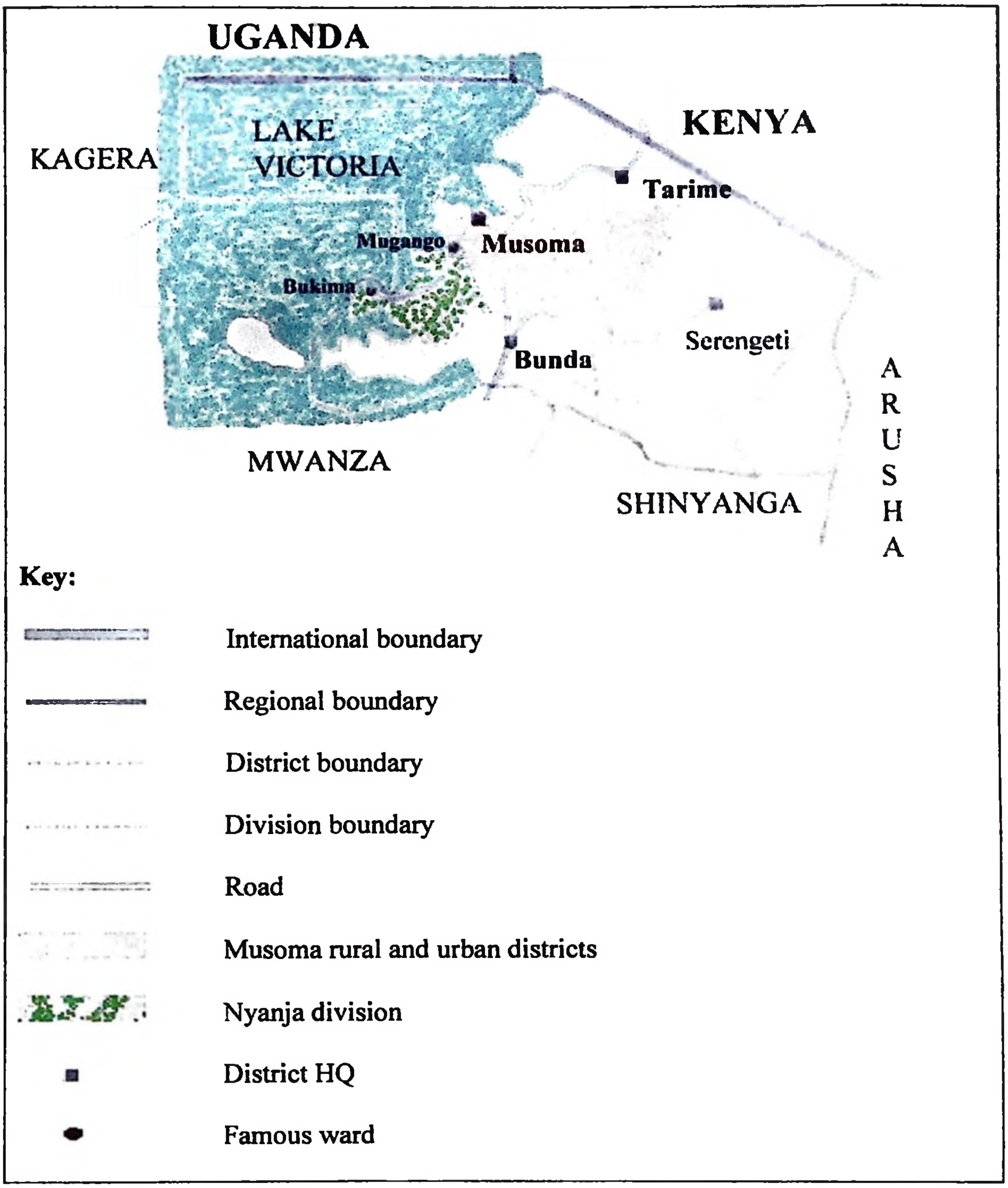
- Land - 3981 km^2
- Water - 300 km^2
- Total - 4281 km^2

Population in 2002 census was about 330953 with the average household size of 5.5 people. According to Anon (1998) population density in Musoma rural district is between 50-100 people per km^2. The main ethnic group in terms of its number is the *Jita*. Other small ethnic groups are the zanaki and ikizu.



Source: Aidan (2000)

Figure 2: Location of Mara region in Tanzania



Source: Aidan (2000)

Figure 3: Location of Nyanja division in Musoma Rural district, Mara region

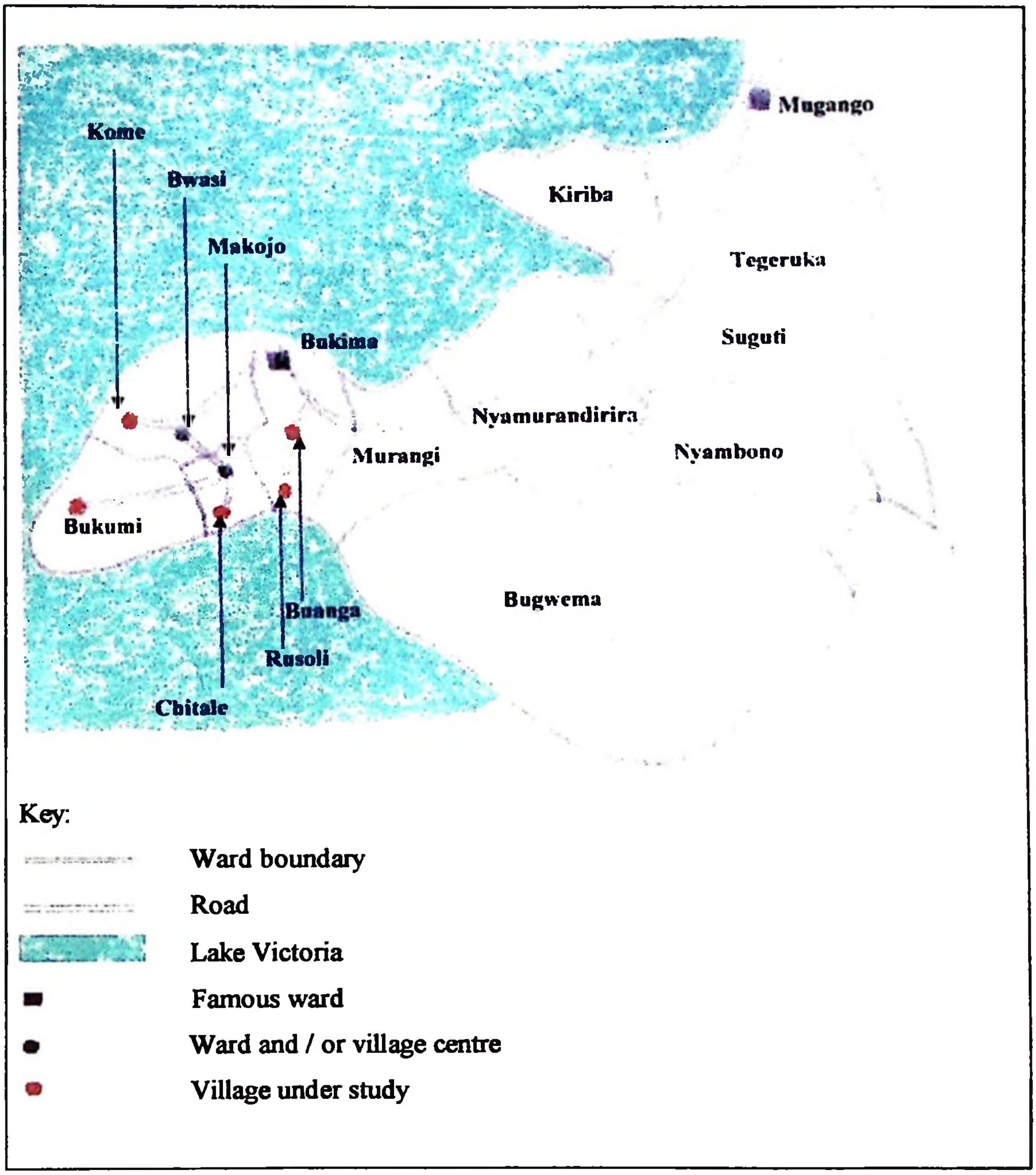


Figure 4: Location of study villages in Nyanja division

3.1.3 Altitude and climate

The district experiences a dry tropical type of climate with rainfall averaging between 700-900mm per annum. The minimum temperature is 12.9^{0}C experienced in June and October while the maximum is 34.7^{0}C experienced between January and mid- march. The Eastern part gets rain twice a year and suitable for coffee cultivation. According to De pauw (1984) cited by Mowo *et al.* (1993), Musoma rural district can be categorised as medium altitude plains agro ecological zone. Anon (Undated) further divides the district into two agro ecological zones (the midland and lakeshore).

The Midland Zone: Altitude of the zone varies from 1,300 to 1,500 meters above sea level. Rainfall is highly variable and increases with increasing altitude, ranging from less than 900 mm per year near the lakeshore zone to over 1,250 mm in the area bordering Serengeti National Park.

The Lakeshore Zone: This zone occupies an estimated area of 3,500 km^2, which includes Nyanja division. It is characterized by altitudes between 1,100 and 1,200 meters, warm temperatures and annual rainfall of less than 900 mm falling from mid-September to early December and from March to June. Duration of rainy season is highly variable. Therefore planting dates and general timing of farm operations are difficult to forecast and mid-season dry spells are common.

3.1.4 Soils and natural vegetation

According to Anon (undated) the lakeshore zone has varied soils. They include, well drained, moderately deep, to deep red, yellowish red sands and loamy sands with low to very low fertility. Natural vegetation is mainly the savanna (woodlands, wooded grasslands and bush lands).

3.1.5 Economic activities, water and forests

The major economic activities in Musoma rural district are agriculture, fishing, livestock keeping, mining and cotton processing industry. Food crops grown in the district include cassava, maize, bulrush millet, finger millet, paddy and sweet potatoes. According to Mowo *et al.* (1993) and Aidan (2000), groundnuts are also grown in the district. Main cash crops are cotton and coffee. Fishing is done in lake Victoria, on an estimated area of 300km^2.

According to the 1984 livestock census, the estimates of livestock in Musoma rural district were 272,635 cattle, 90,606 goats and 40,257 sheep (Anon, undated). Some small-scale gold mining is taking place at Sirorisimba, Buhemba, Nyasirori, Kataryo, Seka, Suguti, Nyarufu and Ikungu. There is a single cotton processing industry in the district, namely Mugango Ginnery and Oil Processing Plant. Water facilities in the district by 1995 were 99 wells, 1 dam and 10 piped schemes. The status of forests is presented in Table 1.

Table 1: Forest Resources (Hectares) in Musoma Rural district

Name/type of forest	Category	Area (Ha)	Ownership
Kyarano (P.F.R)	Protected	2765	Central Government
Mukendo (P.F.R)	Protected	175	Central Government
Musoma Ranges (P.F.R)	Protected	5	Town Council
Bisumwa (P.F.R)	Protected	95	Local Government
Buruma (P.F.R)	Protected	200	Local Government
Departmental plantation	Protected	50	Local Government
Village plantation	Protected	150	Local Government
Woodlands	Protected	228000	Local Government
Total	Protected	239490	

Note: P.F.R = Proposed Forest Reserve.

3.2 Research design and sampling procedures

Basically the study involved a social survey in Musoma Rural communities specifically Nyanja division. Systematic random sampling was used to select households from all five villages where Nyanja Agro-forestry Project was implemented. The villages included Chitare, Bukumi, Kome, Rusoli and Buanga, which were treated as separate strata in order that sampling error could be minimised and precision increased. Available village household lists were used in this exercise.

The sample size was determined by the pilot survey/pre-testing. The number of sampling units/households was equally allocated in each village due to the fact that pre-testing results would seem to be so inconclusive that each village would require a maximum number. Equal allocation is determined by:

$$Ni = \frac{N}{n_i}$$

where:

Ni = number of sampling units in each village.

N = total number of sampling units in the five villages (sample size).

n_i = number of strata (villages) = 5

In this case 40 households were allocated in each village as sampling units.

3.3 Pre-testing

District and village governments were visited so as to introduce the study objectives to the leaders and obtain secondary data that was useful for sampling and analysis purposes. A total of 30 households were interviewed using an open-ended questionnaire so as to test questionnaire reliability and determine parameters that assisted in determination of sample size given that:

$$N = p\sum p_i s_i^2 / \left(\frac{p^2 e^2}{t^2} + \sum p_i s_i^2 \right)$$

where:

N = total number of sampling units (sample size)

p = total number of households in all five villages

p_i = number of households in i^{th} village

s_i^2 = variance of i^{th} village

e = sampling error

t = tabulated value

But:

$$S_i^2 = \frac{\sum Xj^2 - \frac{(\sum Xj)^2}{n}}{n-1}$$

Where:

X_j = the number of trees in j^{th} sampling unit (a household in this case).

n = number of sampling units in i^{th} stratum (a village) before actual data collection.

And:

$e = 10\% \quad \bar{X} = 9.7$ trees

But:
$\bar{X} = \Sigma R_i \bar{X}_i$ = overall mean (weighted mean)

Where:
R_i = Proportion of the stratum (village) households to total households $\left\{ \frac{P_i}{P} \right\}$

$\bar{X}_i$ = mean of i^{th} village $\left(\frac{\Sigma X_i}{n} \right)$

With 30 households the sampling error was 23 trees (24%) and confidence limits would lie between 74.1 and 120.53 trees at 95% level of probability (Table 2). Because of the observed low degree of precision sampling error was reduced to at least 10% (9.7 trees), which resulted to 157 households as the sample size that would be used for actual data collection (Appendix 3). However, a total of 200 households were sampled in order that each village could be allocated with a reasonable number of sampling units.

Table 2: Descriptive statistics for the stratified pilot sample (n=30)

Parameter	Village					Overall
	Bukumi	Rusoli	Kome	Chitale	Buanga	
Number of households	320	399	360	463	305	
Average number of trees	133.5	165.3	77.2	38	83.8	
Standard deviation	6	107.7	35.8	15.1	86.2	
Overall mean						97.3
Standard error						11.6
Confidence limits						74.1 to 120.5

3.4 Data collection

3.4.1 Secondary data

These were collected from different stakeholders, village governments mainly on the number of households in each village, average tree population in each village, species planted in farms, existing policies and strategies and problems encountered in the course of promoting agro-forestry practices.

3.4.2 Primary data

PRA (Participatory Rural Appraisal) tool was used for the purpose of opening up discussions with villagers as well as ensuring relaxation and cooperation during further interviews. PRA also assisted in triangulation so as to make information more reliable. The discussion had been such that a general overview on respondents' perception of environmental problems and technology characteristics was realized. The discussion also allowed some suggestions on how to improve the existing situation.

PRA was carried out by making use of transect walk, mapping, Venn diagrams and time line. Village mapping was used to estimate the sizes and shapes of villages and locate some physical features e.g. hills and valleys. It was also used to collect information on such aspects as location and distances from water sources for home consumption, location and distance from firewood sources as well as that of the farms/fields as these have the influence in labour factor. Time line assisted in telling when major events occurred e.g. draught, floods, hunger and dangerous pests or crop diseases. The Venn diagrams assisted in identifying important institutions, which are within the villages and those, which are outside.

Participant's observations and informal discussions with villagers were done. Farm inventory was carried out to determine structure and composition of agro-forestry. A sample of 200 households was used to generate primary data. All households sampled were visited, and a well-structured questionnaire (Appendix 1) was administered to households' respondents with the aim of collecting detailed and more quantifiable information. The confidence interval at 95% level of probability with respect to the number of trees was 37.7 to 54.7 (Table 3). Checklist (Appendix 2) was also used to interview the agricultural extension officers and foresters in the study area.

Table 3: Descriptive statistics for stratified major survey (n=200)

Parameter	Village					Overall
	Bukumi	Rusoli	Kome	Chitale	Buanga	
Number of households	323	399	360	463	305	
Average number of trees	23.6	66.6	57	27.6	59.1	
Standard deviation	46	79.9	34.8	31.5	56.2	
Overall mean (weighted)						46.2
Standard error						4.2
Confidence limits						37.7 to 54.7

3.5 Data Analysis

- Content analysis was done to analyse in detail the data generated from PRA and the components of verbal discussions held with village extension workers/ professional foresters and farmers. According to Kajembe (1994), this is the breaking down of recorded dialogue with the respondents into the smallest meaningful units of information or themes and tendencies that help in ascertaining values and attitudes of the respondents.

- Both qualitative and quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) program at Sokoine University of Agriculture. Descriptive statistics were used to describe the general information from the respondents, including means, ranges, standard deviations, proportions, and percentages.
- Linear regression analysis was done to determine socio-economic factors that influence the rate of adoption. Logistic regression model was employed to fulfil the general objective of the study basing on the fact that the dependent variable was dichotomous (taking the value of 1 or 0) Koutsoyiannis (1977) pointed out that, in such functions the disturbance term is always heteroskedastic (heterogeneous variance), thus maximum likelihood (ML) estimation procedures are employed instead of OLS estimation procedures. An index of 50 trees planted by the households was used to denote adoption (1), while less than 50 trees was considered as non-adoption (0). 50 trees represent 50% of the target that had been intended for 4 years of the NAP implementation. The average number of trees per household (46.2) was close to 50. Therefore 50 trees was preferred as a cut off point in order to catch a good number of adopters. In general, regression models have widely been used in various socio-economic studies with minimum limitations, for example by Kessy (1992), Caveness and Kurtz (1993), Kessy and O'Kting'ati (1994), Jere (1995), Shiferaw and Holden (1998), Lazaro *et al.* (1999), Kalineza *et al.* (2000) and Senkondo (2000).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents study results and discussion, describing the general farm households, characteristics of sampled households, household resources and characteristics, rate and intensity of adoption, socio-economic factors influencing the adoption of agro-forestry and finally options for enhancing the adoption of agro-forestry.

4.1 General description of farm households

4.1.1 Total population and resources

Estimates from village records revealed the study area to have a total of about 15416 people and 1850 households (Table 4) with the average numbers of individuals per household 6.1, 7, 9.5, 7.5 and 12.3 for Bukumi, Rusoli, Kome, Chitale and Buanga villages respectively. An overall mean was 8.5, which is above that revealed by the population census of 2002 (6.1) as the household size for Musoma Rural district and is also above the regional and national averages (5.5 and 4.9 people per household respectively). It is therefore likely that the large household sizes in most of the villages of the lakeshore zone contributed to a higher regional average than that of the nation and other highly populated regions like Dar es Salaam, Kilimanjaro, Kagera and Mtwara (Table 5).

Table 4: Population and resources in the study area

Village	Population			Resources (Number/Hh)			
	Households	People	Hh size	Cattle	Goats	Sheep	Trees
Bukumi	323	1998	6.1	1.5	1.2	< 0.1	11.8
Rusoli	399	2793	7	1.4	0.4		50
Kome	360	3420	9.5			< 0.1	24
Chitale	463	3465	7.5	1.2	0.4	0.1	39
Buanga	305	3740	12.3	1.6	0.3		100
Total	**1850**	**15416**	**8.5**	**1.4**	**0.6**	**< 0.1**	**44.96**

Table 5: Comparison of Mara region with other highly populated regions in household size

Region	Population density	Household size
Dar es Salaam	1793	4.2
Mwanza	150	5.9
Kilimanjaro	104	4.6
Kagera	72	5.2
Mara	70	5.5
Mtwara	68	3.8

Source: Anon (2003)

The overall average number of animals according to village records, were 1.4 for cattle, 0.6 for goats and less than 0.1 for sheep. These animals may destroy farm trees if left to forage freely.

According to village reports, the number of trees per household at Bukumi, Rusoli, Kome, chitale and Buanga villages were 11.8, 50, 24, 39 and 100 respectively resulting to an overall average of 44.96 trees per household. Due to the daily fuel wood demand of households this average would seem to be unsatisfactory. According to Lounela and Lunkkanen (1991), the average amount of fuelwood used for cooking is between two to four bundles per week for a household in Tanzania. The respondents reported to mostly use the dry cassava stems for cooking because a household can hardly collect one bundle of fuelwood per week from hills.

4.1.2 Characteristics of the sampled households

Table 4.3 summarises the general characteristics of the sampled households. According to the findings of this study, the minimum household size was 2 and the maximum was 20 people per households. The smallest households were of the nuclear type, composed of old husband and wife, while the largest ones were polygamous and/or extended families. The overall household size mean was 7.8, which is above that reported by Anon (2003).

According to the 2002 population censust, the average household sizes in Bukima, Makojo, Bwasi and Bukumi wards were 6.2, 6.6, 6.9 and 6.5 respectively. Findings of this study revealed that Chitale and Bukumi villages have the mean household sizes that are within the average of their respective wards (Makojo and Bukumi) while the rest of the villages have the mean household sizes above the average with respect to Bukima and bwasi wards (Table 6). Thus it can be deduced that most of the polygamous and extended households in the study area would be found at Rusoli, Buanga and Kome villages.

Both the sample size and its total number of people comprised about 10% total households and population of the area under study. The proportions of female and male adults were 24% and 23% respectively and this accounts for a total of 47% average household labour reported to be involved in farm activities.

Table 6: Characteristics of sample population by village (n = 200)

Characteristics	Village					Total
	Bukumi	Rusoli	Kome	Chitale	Buanga	
Population (No)						**1565**
Hh size (mean)	6.5 (2.63)	8.6 (2.77)	9.7 (3.12)	6.6 (2.88)	7.8 (3.13)	7.8 (3.13)
Female (%)	7	11	13	9	10	49
Male (%)	9	11	13	8	8	51
Adults (%)	9	11	12	8	11	48
Children (%)	7	11	14	9	11	52
Female adults (%)	4	6	6	5	3	24
Male adults (%)	5	5	6	3	4	23
Female children (%)	4	5	6	5	5	25
Male children (%)	4	6	7	4	6	27
Secondary School students (No)	6 [0.38]	3 [0.19]	1 [0.06]	5 [0.31]	3 [0.19]	18 [1.1]
Primary school children (%)	5	6	6	5	7	29
Pre-school children (%)	2	4	5	4	4	19
Children peasants (%)	-	-	-	-	-	4

The figures inbrackets '( )' and '[ ]' are the standard deviations and percentages espectively, there have been a rounding off.

For the case of respondents (Table 7), 17% were females of whom 15% comprised singles, widowed and divorced while 83% were males. This would indicate that most of married women in the study area are deprived from decision-making by culture and probably always so occupied by household duties that they can rarely attend extra activities.

Table 7: Background characteristics of respondents by village (n=200)

Characteristics	Village					Total
	Bukumi	Rusoli	Kome	Chitale	Buanga	
Sex						
Female (No)	5[2.5]	4[2]	5[2.5]	12[16]	8[4]	34[17]
Male (No)	35[17.5]	36[18]	35[17.5]	28[14]	32[16]	166[83]
Marital status						
Married (No)	35[17.5]	36[18]	35[17.5]	28[14]	36[18]	170[85]
Single (No)	1[0.5]	2[1]	5[2.5]	6[3]	2[1]	16[8]
Divorced (No)	-	-	-	1[0.5]	-	1[0.5]
Widowed (No)	4[2]	2[1]	-	5[2.5]	2[1]	13[6.5]
Age						
Old (%)	10	12	16	10	11	60
Young (%)	10	8	4	10	9	40
Mean (years)	44.4(16.7)	49.9(14.69)	53.8(11.9)	44.2(14.16)	45.6(14.6)	47.6(14.83)
Level of education						
Informal (%)	1[0.5]	1[0.5]	9[4.5]	6[3]	1[0.5]	18[9]
Primary	31[15.5]	33[16.5]	29[14.5]	26[13]	35[17.5]	154[77]
Secondary	3[1.5]	5[2.5]	1[0.5]	4[2]	1[0.5]	14[7]
Adult	5[2.5]	1[0.5]	1[0.5]	4[2]	3[1.5]	14[7]
Occupation						
Agriculture	39[19.5]	40[20]	39[19.5]	40[20]	39[19.5]	197[98.5]
Civil servant	1[0.5]	-	1[1.5]	-	1[0.5]	3[1.5]

The figures in brackets '( )' and '[ ]' are the standard deviations and percentages respectively. Figures are rounded off.

About 60% of the respondents were old (above 41 years) while 40% were the young people (below 40 years) (Table 8). With respect to the age groups there is an indication on one hand that in the *Jita* communities a young male can marry at 20 years of age and form an independent family. On the other hand there are households headed by economically less active old people, that is, those above 65 years of age whereby the later might have an effect on labour required for farm activities. The overall average age was 47.6 years.

Table 8: Description of the age groups of respondents in the study area

	Age group (yrs)	Frequencey	Valid Percent	Commulative
Valid	20 – 30	21	10.7	10.7
	31 – 41	65	33.0	43.7
	42 – 52	46	23.4	67.0
	53 – 63	36	18.3	85.3
	64 – 79	29	14.7	100.0
	Total	197	100.0	
Missing	System	3		
Total		200		

Findings reveal that 91% of the respondents were literate, of whom 77% attended primary education, 7% adult education and 7% attended secondary education. This would enhance the learning process of agro-forestry practices through reading and writing. However 9% of the respondents were found to have informal education. In terms of occupation 98.5% are engaged in agriculture while 1.5% is civil servant (teachers and village administrators), implying that, data on the farm related problems would seem to be highly reliable, as they have been identified from farmers themselves who have more or less similar experience.

4.2 Household resources and characteristics

The common household resources found in the study area include land, crops, trees, livestock, household labour, water and off farm income as presented in Table 9.

Table 9: Household resources and characteristics by village

Resource	Village					Total
	Bukumi	Rusoli	Kome	Chitale	Buanga	
Farm size (mean ha) (n=195)	1.5(1.27)[0]	2.4(1.51)	2.5(1.78)	2.79(1.4)	2.67(2)	2.14(1.67)
Crops (mean ha) (n=134)	1.6(0.7)[1]	1.8(1.18)	2(1.36)	1.2(0.8)	1.7(1.07)	1.7(1.12)
Agro-forestry (mean ha) (n=112)	1(0.3)	0.5(0.25)	1.3(1.53)	1.5(1.46)	1(1.84)	1(1.26)
Livestock (No/Hh)						
Cattle	2.95	2.3	2.2	1.2	1.3	2
Goat	1.25	1.75	2.34	2.9	2.12	2
Sheep	<0.5	<0.5	-	-	<0.5	0.63
Farm labour (No/Hh)	4(1.94)	3.5(1.28)	4.5(1.98)	2.7(1.24)	3.4(1.52)	3.7(1.74)
Water (mean hours spent)	0.9(0.38)	1.7(1.34)	1.7(2.8)	0.9(0.63)	1.6(1.05)	1.3(1.55)
Off farm income (%respondent)(n=181)						
Business	3	3	1	1	5	13
Fishing	11	9	10	4	3	37
Formal employment	1	-	1	2	1	5
Informal employment	4	6	4	9	11	34
Business & fishing	0.5	0.5	1	1	-	3
Business & informal employment	0.5	0.5	2	0.5	-	3.5
Handcraft	0.5	-	0.5	2	-	3

Figures in brackets are the standard deviations

[0] n=39
[1] n=5

4.2.1 Land holdings

Although the area has been categorized by anon (undated) as the lakeshore agro ecological zone and by De pauw (1984) cited by Mowo et al (1993) generally as the medium altitude plains, three main physical features could be observed, that is, hills, plains and valleys. Most of hills are rocky with sparse bushes[3] (Figure 5) and as reported by farmers, hills are commonly owned and this is one of the sources of household fuel wood. Crops Such as cassava, maize, sorghum, pigeon peas, beans and cotton are cultivated on plains and at the foots of hills while the valleys are for cultivation of rice, sweet potatoes, to a small extent, banana and vegetables. Thus households' plots for crop cultivation are found on plains and valleys.

Figure 5: Bare hills as the source of fuel wood

[3] Farmers could associated it with deforestation because in the past the hills were covered by a lot of big trees.

Homesteads are located relatively closer to the lake or ward centres so as to enable accessibility to water, activities such as fishing and business as well as accessibility to social services like transport and health. Therefore ownership of more than one plot of land (homestead and distant plots) is common in the area under study.

Findings revealed that yellowish red sands with very low fertility characterise a large proportion of the study area (Figure 6) similar to what had been reported by Anon (undated). Soil infertility was reflected in poor performance of crops and this was mentioned by more than 50% of the interviewed households as one of the reasons for household food insecurity and a constraint to agro-forestry practices. Farmers also reported that, the high temperature of sands especially during dry seasons contributes to failure of certain species of young trees such as *Sesbania sesban* and *Gliricidia sepium*, which are planted in distant fields.

Figure 6: Soil characteristics in the most parts of Nyanja division

It has been evidenced that land is highly scarce in the study area nevertheless it is the most important resource for rural livelihood. The minimum and maximum farm sizes found were 0.4 and 9.3 ha respectively. In general, 45.1% of respondents were found to own farm sizes ranging from 0.4 – 1.4 ha while 32.8% and 8.7% of respondents owned 1.5 – 2.5 and 2.6 - 3.6 ha respectively. Only 13.3% of the respondents were found to own farm sizes of above 3.7 ha and moreover, 3% of the sampled households were found to own no piece of land at all.

Land acquisition system is largely dominated by inheritance and provision by clan as illustrated in Figure 7. Due to this system and increasing population pressure, there has been a feeling of land tenure insecurity as farmers think that there is a day when they will be forced to move to new areas so as to solve overpopulation problem.

Senkondo (2000) pointed out that, the absence of legal tenure rights to land ownership has always been a major problem in agricultural production and environmental conservation in Babati district, Arusha region. On contrary, Epaphra (2001) found that all the interviewed farmers in Marangu and Mamba, Kilimanjaro region, were practicing the home garden type of agro-forestry system despite the fact that the common modes of land acquisition were through inheritance and clan allocation. For regions like Kilimanjaro and Kagera the advancement of agro-forestry practices might have been contributed by favourable climatic conditions that may also outweigh the effect of land tenure and land scarcity problems. The opposite may be true for semi arid areas.

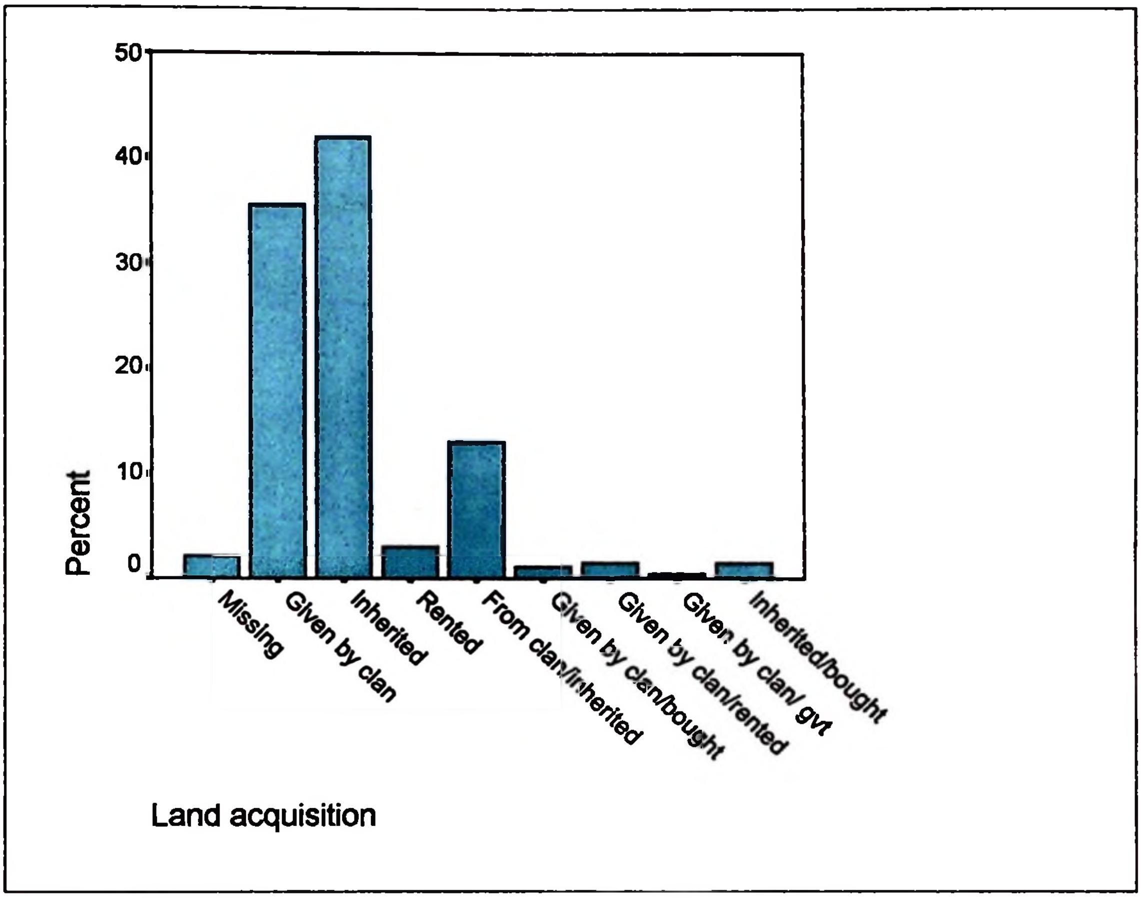


Figure 7: Land acquisition system presented as percent respondents

4.2.2 Crops

Findings have shown that most farmers allocate an average of 1.7ha (Table 10) for crop cultivation. The types of crops that are cultivated in Nyanja division are presented in Table 11. Cassava is the main staple food in the area and evidence has revealed that this is the dominating crop cultivated by 99% of the sample households. To some extent the crop is adapted to semi arid environment as well as infertile soils.

Table 10: Types of crops cultivated in Nyanja division

Type of crop	% of respondents cultivating a crop
Cassava	99
Sweet potato	89
Paddy	44
Cotton	38
Sorghum	34
Maize	30
Beans	26
Cow peas	<3
Banana	<2
Vegetables	<1.5
Groundnuts	<0.5
Finger millet	<0.5
Sugarcane	<0.5

Sweet potato was the next after cassava as it can establish well in valleys during dry seasons. Cotton is the main cash crop while paddy serves for both food and cash purposes. The contribution of cotton to the household income is highly appreciated by farmers but the practice of burning cotton residues during fields preparation has been condemned as the main cause of fire incidences, hence farmers' tendency to avoid risk towards tree planting.

Findings reveal that there is a gradual disappearance of the main original staple food, sorghum due to environmental factors for example the emergence of striga weed while finger millet is almost disappearing due to inadequate and unreliable rainfall as well as soil infertility. Bulrush millet does no longer exist due to the same reasons. Thus the risk factor is also revealed in cropping pattern.

Cropping calendar

Like in the other parts of Mara region Nyanja division experiences short and long rainy seasons. The starting dates are unpredictable with the duration increasingly shortened due to general weather changes. It was reported that in the past the short season started in late September extending to December while the long season started in early February through May. Currently the short rainy season has shifted up to November/December while the long season lasts from March to April.

Cropping activities normally start in September through July and the high concentration of activities is experienced in November through May. In September most farmers are busy with fields preparation, which is normally done by men. The planting of crops such as maize, sorghum, and cassava is done in October and March. Weeding starts four weeks after planting. Maize and sorghum are harvested in January through February and July through August subject to the varieties while cassava is gradually harvested after one year depending on the household's needs. Paddy and cotton are planted only once a year specifically in February and November and rotate for five and seven months respectively. Beans, cowpeas and groundnuts are intercropped with either cassava or maize. A large proportion of sweet potato is planted in valleys after the harvest of paddy. Women do the overall task of potato production, which renders them occupied by farm activities throughout the year, hence a limited time for women to plant trees.

Similar to crops, tree planting is supposed to be done during rainy season but due to limited labour and the fact that priority is given to crops, the activity is done towards the end of the season. In this case only a few trees are planted and the same experiences a long period of drought resulting to failure of non-resistant species. The reason for farmers' tendency of giving first priority to crop production is that, crops have a direct contribution in household food security. Income from crops was also found to be higher than that from livestock and trees (Table 11).

Table 11: Average annual income (Tshs) from household resources during the year 2000 to 2002

Year	Item		
	Crops (n=35)	Livestock and its products (n=10)	Trees and its products (n=12)
2000	71000	41000	27000
2001	66000	49000	26000
2002	51000	34000	33000
Overall mean	63000	41000	28000

Evidence suggests an annual decrease in income from crops (Figure 8) indicating a decline in crop yield that leads to reduced surplus for sale. An average income from crop sale was about Tshs 71000, 66000, and 51000 in the years 2000, 2001 and 2002 respectively. For the case of livestock and trees there was no clear trend because harvests are not annually specified.

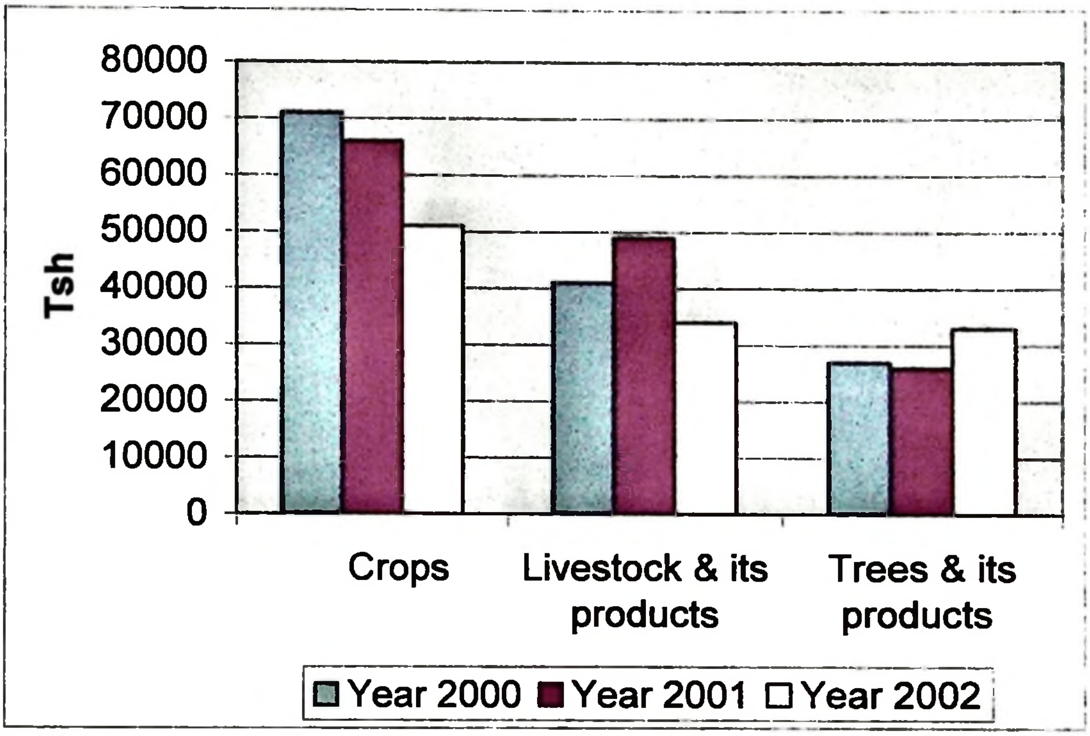


Figure 8: Average earnings from household resources

4.2.3 Agro forestry

Structure of agro forestry

Agro forestry practices in the study area comprised of tree home gardens, wind breakes, shelterbelts, shade trees in cropland, scattered trees in cropland, live fences, alley cropping, block planting, live hedges, woody strips, shifting cultivation and animal production in woodland. The respondents were found to engage themselves in one or more than one type of agro forestry practices as summarized in Table 12 with 1ha average land size allocated for the practices.

Table 12: Structure of agro-forestry in the study area

Type of agro-forestry practice	Percent respondents
Tree home gardens	66
Wind brakes	21
Shelterbelts	17
Shade trees in cropland	16
Scattered trees in cropland	14
Live fences	8
Alley cropping	5
Block planting	4
Live hedges	3
Woody strips	3
Shifting cultivation	2
Animal production in woodland	0.5

Although it would seem not to be advanced, tree home garden is emerging in Nyanja division, which agrees with the report by Nair (1993) that home gardens are among the common forms of agro-forestry in densely populated areas. Empirical evidence reveals that tree home gardens have been one of the farmer's trials to intensively use limited land resource to sustain nutritional, fuel wood, fodder, soil conservation and income needs. Tree home gardens in Nyanja division are mainly composed of either one or more fruit trees, largely *Citrus sinensis, Anona muricata, Carica papaya, Persea Americana* as well as *Psidium guajava* and other tree species, to a large extent *Melia azedarach, Cedrella odorata, Makhamia lutea*, and *Azadirachta indica*. In most cases cassava crop is found mixed with trees around the homesteads.

Due to land scarcity problem, shifting cultivation and animal production in woodland are taking place in Bugwema ward (Figure 4) where population density is still low. The practices are carried out by a few farmers who sometimes move to Bugwema ward. However these farmers have never stayed in Bugwema on a permanent basis due to lack of social services specifically water especially during dry season.

Composition of agro-forestry

Like in other regions where land degradation is critical, the Vi agro-forestry experts in Mara region to a large extent have been promoting specific tree species. These would improve the livelihood of the local communities and cater for soil improving as well as conservation purposes. However according to empirical evidence, composition of agro-forestry in Nyanja division would seem to depend on farmers' preference of species, which is determined by factors other than the mere environmental problem.

Performance of the tree species in relation to the environment, its effect on the soil, the direct economic and nutritional benefits as well as the type of farming system may lead farmers to mostly preferring some of the species and rejecting others. For instance, during the implementation of NAP, the main tree species that were promoted include *Khaya anthotheca, Melia azedarach, Eucaliptus spp, Carica papaya, mangifera indica* and *Citrus sinensis* while Vi agro-forestry do promote *Cedrella odorata, Albizia lebbeck, Gliricidia sepium, Sesbania sesban, Cajanus cajan, Anona muricata, Carica papaya, Citrus sinensis and Persea Americana* tree species.

From experience, farmers evaluated *Melia azedarach*, as drought and pest resistant, fast growing, not browsed by animals and economically beneficial kind of tree. According to farmers report, a six years old tree can be sold at Tshs 25000 equivalent to US$ 23.8*, which is really a business if a person has many trees. A minimum price for a young tree is Tshs 2000 equivalent to US$ 19 and for a mature tree the maximum price is Tshs 60000 equivalent to US$ 57.3. The tree is useful in producing fuel wood and timber for house construction, and furniture making. However, together with the associated positive characteristics the tree competes with crops for nutrients and that is why it is mostly found in tree home gardens and rarely in crop fields (Figure 9).

Figure 9: Main composition of tree home gardens in the study area

Similarly *Cedrella odorata* was reported to be non harmful to the soil, drought resistant and fast growing tree. It is useful for timber production but income realization could not be estimated because this specie is new to the area and during farm inventory the trees

* Exchange rate used is 1 USD = 1050 Tshs

were still young as illustrated in Figure 10. Basing on the evidence, *Melia azedarach* would seem to dominate the study area by 32% in abundance whereby the species has spread to 74% of the respondents and it is followed by *Cedrella odorata* (Table 13). Thus more than 50% of the trees in the study area consist of the two described species due to farmers' perception that the same are highly economically profitable, and thus, findings by Carry and Wilkinson (1997) would hold positive.

Table 4.10: Abundance of the promoted agro forestry tree species (%respondents[1] and tree species[2])

Tree species	% of respondents	% of tree species
Melia azedarach	74	32
Cedrella odorata	39	20
Khaya anthotheca	5	2
Eucalyptus spp	9	3.5
Carica papaya	41	5
Mangifera indica	34	5
Citrus sinensis	34	5
Anona muricata	39	5
Persea Americana	5	1
Albizia lebbeck	26	6
Sesbania sesban	11	3
Glirisidia sepium	3	0.5
Cajanus cajan	2	0.4
Total		**Total 88.4**

[1] Percent of respondents having the tree specie in their field (n=200)
[2] Percent of tree species, which was determined from its ratio to the total number of trees (about 9400)

Figure 10: *Cedrella odorata* species at the young stage in the distant fields

With respect to *Eucalyptus spp* and *Khaya anthotheca*, although they could ensure economic gains from timber, a certain degree of rejection by farmers is obvious firstly, due to the fact that the former was reported to highly compete with crops for water and nutrients, and secondly, the later has a long rotation period.

All fruit trees under inventory sum up to 22% in abundance with *Carica papaya*, *Citrus sinensis*, *Mangifera indica*[*] as well as *Anona muricata* accounting for 5% each. From history, *Mangifera indica* has been regarded by the lakeshore communities as food reserve during severe food shortages. For instance during 1990/1991 hunger, the people of this zone could survive by eating fish with cooked or ripen mango fruits. During food availability mango fruits are sold. However due to transportation problems to town where a reasonable price can be realised, a farmer can hardly earn Tsh10000 equivalent

[*] Most of the trees were grown since colonial era and they are the main shade trees retained in fields

to US$ 9.5 annually from a mango tree with maximum production as can be observed in Figure 11. Because of this low income, most farmers are starting clearing mango trees from their fields so that more space can be available for cultivation of cassava crop.

Figure 11: Mango tree retained as household food reserve

These farmers are also shifting to papaya establishment in home gardens as a nutritional supplement or replacement for mango. Papaya was reported to be highly resistant to drought, fast growing, highly productive and it has a limited shading effect on crops. *Citrus sinensis* is dedicated to both nutritional needs and business. Mbuya *et al* (1994) pointed out that *Anona muricata* has low yields as a tree can hardly produce more than a dozen fruits. However, results have shown that this species is spreading fast amongst farmers due to its insecticidal properties and it can be used to kill fish. The rest of fruit trees, including *Psidium guajava, Persea Americana, Syzygium cuminii, Mussa* *sapienam* and *citrus limon,* have been established to meet daily nutritional needs. They are fewer in number and are grown by a few respondents.

With the exception of *Albizia lebbeck,* which is grown by 26% of the sampled households and was 6% in abundance, the rest of promoted soil improving tree species, (including *Glirisidia sepium, Sesbania sesban* and *Cajanus cajan*) would seem to be in the state of rejection by farmers. The low percentage of the later might have also been contributed by the fact that the species experience high death rates as a result of high soil temperatures, drought and pest attack.

In total, 34 types of tree species that have been retained or planted by the sample households were identified (Appendix 4) summing up to a count of about 9400 trees. It is encouraging to find out that 88.4% were the thirteen species promoted by NAP and Vi agro-forestry Project. 11.6% of trees have been established as a result of individuals' interests, the most important one would be the need for hardwood timber revealed by the presence of such species as *Terminalia catappa, Terminalia mentalis, Milicia excelsa, Tectona grandis, Cassia siamea* and *Makhamia lutea.* Mbuya *et al.* (1994) reported that wood products from the first four species are the best for boat making, therefore, in the fishermen communities of Nyanja the species have been geared towards the promotion of fishing industry.

4.2.4 Livestock

To the lakeshore communities, the extent of herding ranks third after cropping and fishing as findings revealed that only 36% of respondents own cattle, 40% own goat and 2% own sheep of which the average number of animals per household was 5.5, 5.2, and

6.2 respectively. It was reported that herders do not control the grazing habit of animals especially after crop harvest when animals are left to move freely in fields causing tree destruction as a result of browsing. In this case livestock contribute to farmers' tendency to avoid risking tree planting.

4.2.5 Farm labour

Findings have revealed that family members largely do farm activities in the study area. The average number of people working in household fields is 3.7 representing the mean number of female and male adults in the household, which is 47% of the household size. However in practice, it is not always possible for all adults in the household to be involved in farm duties because there might exist sick people, economically less active people and those who are involved in non-farm activities like business, fishing and formal employment.

4.2.6 Water

Water is the most important resource without which no any activity can take place in the household. Despite the fact that safe and clean water is needed primarily for drinking, cooking, bathing and washing the same is highly scarce in the study area. It has been evidenced that a woman in the study area spends an average of 1.3 hours to obtain 20 litres of water due to the fact that there are only few traditional wells (2-5) in each village of which some are temporary. The total time spent in this activity depends on the number of active females* in the household and the size of the household. In general, water unavailability has a negative influence on farm labour contributed by women in that searching for water reduces time spent in farm activities.

* Fetching water has been regarded as a female task.

4.2.7 Off farm income

To strive for livelihood farmers in the study area engage themselves in various non-farm activities for income generating purposes (Figure12). The earning may be utilized for clothing, shelter, health, education and nutritional needs. 13% of the respondents reported to be doing petty business for example that of small seasonal shops. Fishing as self-employment was found to involve 37% of respondents and the activity was reported to have the largest contribution to the households' income. 5% had been formally employed, specifically as village administrators, teachers and in a cotton ginning factory, 34% had been informally employed in fishing industry, and as casual labourers. Some of the respondents were found to engage in more than one activity for example business and fishing as well as business and informal employment at the extent of 3% and 3.5% respectively. Handicraft (mainly making fishnets and ropes) is another activity done by 3% of the sample households to generate income.

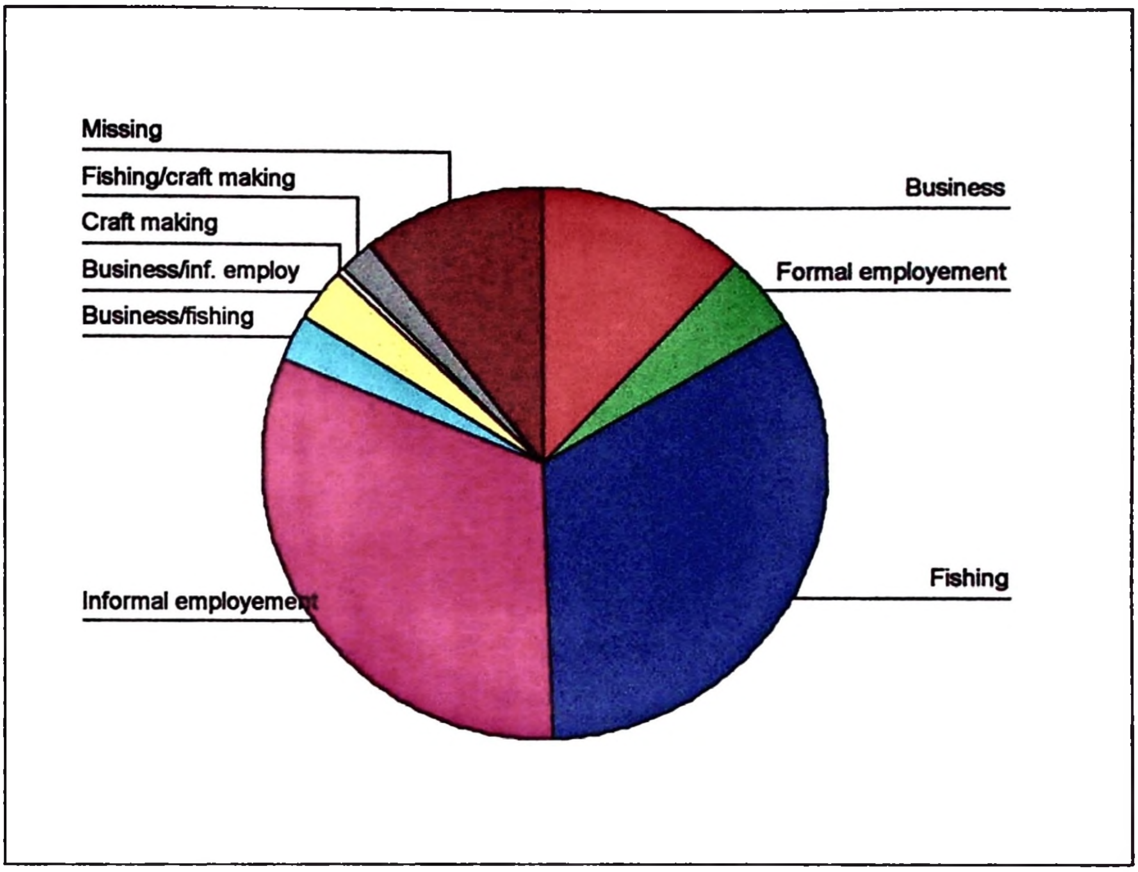


Figure 12: Various sources of non farm income

4.3 The rate and intensity of adoption of agro-forestry practices

4.3.1 The rate of adoption

With respect to this study, two options have been considered in explaining the rate of adoption. The first option is the number of new adopters per year and the second option is the number of trees per hectare. The reliability of the later may be low because only a few respondents could estimate land size allocated for agro-forestry. For the first option, four periods have been considered so as to describe the rate of adoption of agro-forestry in the study area basing on the year in which each respondent started tree planting. The earliest date when tree planting has been reported to have started is 1962 and there was no formal agro-forestry extension up to 1990 denoting the first period of twenty eight years (Before Nyanja Agro-forestry Project) . The second period is from the year 1991 to 1995 when there was technical support from the diocese of Musoma in the course of the implementation of NAP (During NAP). Agro-forestry extension services ceased during the year 1996 through 1998 after evaluation of NAP (Post NAP evaluation), that is the third period. From the year 1999 to 2003, the fourth period (During Vi agro-forestry Project), Vi agro-forestry staff provided technical support to farmers in Nyanja division.

During the first, second, third and fourth periods, 23%, 17%, 10% and 49.6% of respondents started engaging in agro-forestry practices at the rate of 1.2, 5, 5 and 14.6 farmers per year respectively. Findings suggest that the fourth period has experienced a significantly higher rate of adoption of agro-forestry technology than the rest three periods as it can be observed in Figure 13. Generally the resultant rate of adoption since when NAP started is 8.7 people, that is, 6% of respondents per year. From the graph peeks would be revealed in the year 1974, 1980, 1990, 1991, 1995, 1998, and 2000. This tendency may be associated with the following:

- Perception of environmental problem as a result of drought and hunger during 1973-1975.
- Sensitization activities for implementation of NAP in the year 1990.
- Active NAP activities in 1991.
- Adequate rainfall and sensitization activities for implementation of VI AFP in the year 1998.
- Farmer to farmer extension (farmer study tour) in 1995.

➢ Availability of tree seedlings and knowledge acquired as a result of adequate extension services, household tree nurseries and seminars in the year 2000.

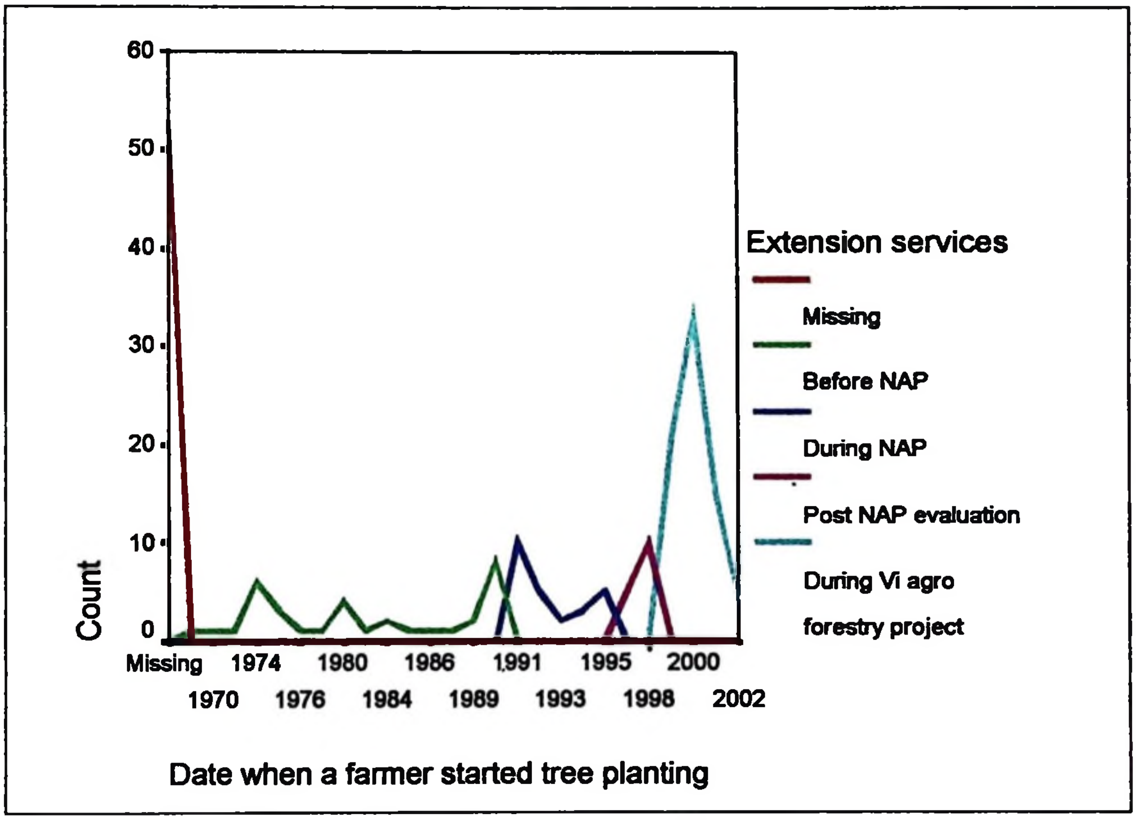


Figure 13: The trend of the adoption of agro-forestry in the study area.

The graph is descending after the year 2000 due to inadequate extension services (resigning and transfer of village extension staff). In summary, the four periods cumulatively contribute to an average of 46.2 trees planted per household per hectare of land.

The rate of adoption in terms of the number of trees per hectare may be positively affected by land availability and knowledge. The results of linear regression in appendix 6 revealed the significance of these factors. However, the goodness of fit for the model was not satisfactory as the factors could explain only 15% change in the rate of adoption. The other proportion may be explained by other factors, probably risk avoidance to a large extent.

In the farmers' identification of constraints on adoption, the prevalence of drought, tree destruction by browsing animals, fire incidences as well as pests and diseases were most frequently mentioned (Table 14). These four factors are the ones that can be considered under the category of risk. Fire incidences could score the minimum points in the ranking test implying the most serious problem in those villages where the burning of cotton residues is common.

Table 14: Farmers' identification of constraints on adoption (n = 185)

Constraint	% Respondents	Ranking scores
Drought	69	1.8
Destruction by animals	64	1.9
Pests and diseases	35	2.4
Fire incidences	27	1.5
Inadequate knowledge	20	>4
Soil infertility	13	>4
Scarcity of land	12	>4
Poor leadership	8	>4
Theft of seedlings and young trees	<5	>4
Culture	<5	>4
Lack of capital	<5	>4
Felling of trees	<5	>4
Lack of seeds	<5	>4

4.3.2 The intensity of adoption

Similar to the rate, two options (the proportion of respondents who have adopted the technology by attaining fifty trees and the proportion of land that is under agro-forestry) can also express the intensity of adoption of agro-forestry practices in Nyanja division. About 33% of respondents in the study area were found to have adopted agro-forestry technology. The chi-square test (Appendix 7) suggests the dependence of the intensity of adoption on the village. Thus from Table 15 the highest intensity of adoption (10.5%) could be revealed in Kome village.

Table 15: The intensity of adoption (% of respondents) by village

Village	Non-adopters	Adopters	Total
Bukumi	37 (18.5)	3 (1.5)	40 (20).
Rusoli	23 (11.5)	17 (8.5)	40 (20)
Kome	19 (9.5)	21 (10.5)	40 (20)
Chitle	33 (16.5)	7 (3.5)	40 (20)
Buanga	22 (11)	18 (9)	40 (20)
Total	134 (67)	66 (33)	200 (100)

The figures in brackets are percentages.

Findings (Appendix 8) show that, for Kome and Buanga villages the adoption of agro-forestry technology may be positively correlated to land size. At 10% level of significance, a positive correlation between age and adoption was found only in Rusoli village. Age of the farmer may have an influence on farmer's perception of environmental problem, deforestation in this case, as the older farmer can clearly make a comparison between the past and current situation increasing the likelihood to adopt. As suggested by Lapar and Pandey (1999), the aspect of longer farming experience by older farmers may have a positive influence on adoption.

However, farmers' tendency to adopt may not necessarily be subject to influential factors in an independence manner but rather to a combination of factors in interdependence behaviour. The influence of land size and age on a doption in some cases may be outweighed by labour and other constraints. Land size can also affect the influence of other factors such as age. For example, Bukumi village with significantly limited land size (an average of 1.5 ha per household) was found to have the lowest intensity of adoption (1.5%) but no relationship was found between land size and adoption. Similarly, there was no correlation between land size and adoption in Chitale and Rusoli (with average farm sizes 2.79 and 2.4 ha respectively) villages probably due to the prevalence of other important factors such as risk avoidance.

An old farmer in one instance might not have adopted the technology due to a small land size or unavailability of enough labour. In the other instance, a farmer with large piece of land might find it risky to invest his/her labour in tree planting due to fire incidences or destruction by livestock. These phenomena may also pose some limitations in regression analyses because some factors, including those related to attitude, are difficult to measure.

With the second option, findings revealed that 46.7% of land owned by the sample households was under agro-forestry practices. However, the reliability of this option may be low due to the poor estimations of the portions of land that has been allocated for agro-forestry by farmers.

4.4 Socio-economic factors influencing the adoption of agro-forestry practices

Statistical significance for factors influencing the adoption of agro-forestry practices was determined by logistic regression model. The relationship between adoption and independent variables may be summarized as:

$\text{Ln } A = a_o + \beta ixi + E$

Where:

A = p/ (1-p) = probability ratio of adoption to that of non-adoption. (1 was coded for adoption and 0 for non-adoption)

p = probability of adopting agro-forestry technology

a_o = a constant

βi = logistic regression coefficients

xi = (a vector of exogenous variable, labour, land size, knowledge, food sufficiency and time)

E = error term

The results in Table 16 would complete the above logistic equation as:

R = -3.2232 + 0.3438LB + 0.1565LS + 1.3693K + 0.0027FS + 0.0524T
0.5681 0.1797 0.0442 0.4405 0.0047 0.3526

Where R = log of the odds ratio in favour of adopting agro forestry while LB, LS, K, FS and T stand for labour (number of female adults), land size (hectares), knowledge, food sufficiency and time respectively (years). The model significance was 0.0000.

Table 16: Socio economic factors influencing the adoption of agro forestry practices in Nyanja division (n=187)[1]

Variable	β	S.E	df	Significance
Labour	0.3438	0.1797	1	0.0558*
Land size	0.1565	0.0442	1	0.0004*
Knowledge	1.3693	0.4405	1	0.0019*
Time	0.0027	0.0047	1	0.5711
Food sufficiency	-0.0524	0.3526	1	0.8819
Constant	-3.2232	0.5681	1	0.0000

Figures with stars are significant

Logistic regression analysis could reveal the significance of labour at probability level, p=0.05, land size and knowledge at p<0.01 in adopting agro forestry. The results of the model indicated that land size was the most significant factor for the Nyanja communities to adopt agro forestry technology followed by knowledge and labour resource.

[1] The details of the logistic regression analysis including correlation matrix are found in appendix 9

The factor land correlated positively to adoption suggesting that households with large plots of land are more likely to adopt agro-forestry technology than those with small plots. This finding may not be compatible with that of Yaron *et al.* (1992) but is in support to that of Kessy and O'Kting'ati (1994). The analysis has shown that land size had a negative correlation with household food sufficiency indicating that small landholders might have chosen other options, for instance the use of farm yard manure to improve crop yield, hence adequate food. In addition, small landholders would seem to be less risk-oriented or less willing to take chance due to opportunity costs.

Similarly, farmers who are knowledgeable or those who are familiar with necessary agro-forestry skills are more likely to adopt than ignorant farmers. Since extension agencies were most frequently mentioned as the main source of information about agro-forestry, these findings emphasise the importance of extension practitioners in equipping individuals with knowledge necessary to use the technology and would parallel to the suggestions by King and Rollins (1995), Senkondo *et al.* (1998) and Kalineza *et al.* (2000). The correlation matrix in appendix 6 indicates that the length of time for which a farmer has been in use of a practice influences knowledge by improving his/her original skills and gaining extra experience.

Further more, the likelihood to adopt agro-forestry is higher for households with a larger number of female adults than those with fewer female adults, implying labour factor contributed by women in agro-forestry. Although Kalineza et al. (2000), Yaron et al. (1992), Senkondo et al. (1998) as well as Lapar and Pandey (1999) could point out a generalised labour requirement as influential to adoption, this study went as further as to the discrimination of who actually are significantly influential.

The fact that frequency distribution indicated only 40% of households having tree planting and management specialized for men may justify the women's contribution in the adoption of agro-forestry. It could also be estimated that more than 50% of male adults were engaged in off farm activities mainly fishing that might contribute to male labour reduction from farm although chart of daily activities indicated that men's working hours did not exceed eight per day. In general women were reported to directly participate in activities such as tree planting as well as tree management for example watering and weeding. In addition, women may have indirect role in agro-forestry through crop production and performing almost all household duties for not less than 16 hours per day. Water and fuel wood scarcity as well as the lack of health services however influences women labour required for tree planting and management.

The length of time of farmer's involvement in a technology was not significant but it positively correlated to adoption. That is, those who started agro-forestry in the past are more likely to adopt than those started recently verifying the influence of experience and knowledge gained. In regard with household food sufficiency, although no significant influence was revealed, results indicated that those farmers facing food deficit problems are more likely to adopt than those who are food sufficient revealing farmers' recognition of environmental problem resulted from deforestation.

4.5 Options for enhancing the adoption of agro-forestry: farmers' participation

The study was interested in sharing experiences with farmers in the view that they are a segmented audience, by letting them identify problems, suggest solutions and indicate their attempts in the following areas:

Agriculture:

- Farmers could identify land scarcity with low fertility as well as drought and unreliable rainfall as the major sources of food insufficiency. It was also reported that about 60% failure of young trees was caused by inadequate rainfall. In response, farmers do apply farmyard manure on crops and trees to improve performance, giving priority to crops during the rain season and tree planting afterwards. They also have opted for drought resistant types of crops and trees. Together with all the attempts made, farmers in the study area requested for water services to facilitate tree management during dry seasons and they suggested research on soil improving techniques and land allocation to new areas be done by government.
- The aspect of inadequate extension staff and inadequate services was reported to affect agricultural activities in the sense that farmers lack the necessary technical packages. The previous role played by NAP and currently by VI AFP is highly appreciated but still there was a request for adequate extension staff.
- A fast spreading cassava disease, suspected to be cassava bacterial blight was reported. Due to the disease, cassava yield may highly be reduced as a result of rotting of tubers. In addition, certain types of tree species like *Cajanus cajan* and *Sesbania sesban* were reported to transmit pests to cassava crop. As a solution to pest transmission, farmers have avoided incorporating the above-mentioned tree species in fields, but for the case of diseases, an immediate technical action from experts was suggested.
- Poor infrastructure specifically roads, was reported to affect the marketing of crops and availability of farm inputs resulting to wastage of time necessary for

field activities. Because the problem is above farmers' ability, an improvement in communication was requested for.

Water:

- Wells in the study area were reported to be few and of short term. The reliable ones are located a long distance increasing women workload and limit field time. A positive consideration for water situation was proposed.

Health:

- Farmers in the study area reported to be less accessible to health services in that, there is a single health center, which is located at an average of above 20km away, affecting labour availability for agricultural activities. To minimize the problem, there was an ongoing construction of a dispensary at Chitale village with a partial financial support from IFAD. However, ideally this would not be adequate yet.
- Unavailability of fuel wood was among the serious problems identified by PRA participants. It was reported to increase both women workload and the rate of deforestation. The major attempt by villages under study has been to set a target, that is, every household should plant 20 trees every year. To cater for current household fuel wood needs, sometimes farm trees are utilized as fuel wood (Figure 14).

Figure 14: ***Melia azedarach*** **species ready for utilization as fuel wood**

Livestock:

- There has been a problem of inadequate grazing land and during dry seasons livestock browses and destroy trees. Herders are charged with fines as an attempt to minimize risk but this was reported to be a difficult task due to arising conflicts between herders and village leaders. Thus there was a request for corporation from policy makers.

Milling machines:

- Women in the study area travel a long distance to get accessible to the milling services. Alternatively they use traditional methods of grinding. Labour factor is affected. A credit and electric services were requested for installation of milling machines

In general, adoption of agro-forestry practices can be enhanced if farmers' reports and attempts are thoroughly investigated and/or supported. Those genuine problems that are not within their ability should be considered positively wherever possible.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Agro-forestry technology in the study area was found to spread at the rate of about 6% population per year contributing to an average of 46.2 trees per household per hectare. The rate of adoption in terms of number of trees per household per hectare may positively be affected by adequate farm size, and knowledge.

The intensity of adoption expressed as the proportion of respondents as a mass audience was 33%. For more than ten years with the practice in use, this figure may be considered as unsatisfactory especially if the need for fuel wood is taken into account. However, chi-square test indicated that the intensity of adoption depends on the village at the level of significance, $p<0.01$, implying the existence of different factors of adoption amongst isolated units within the same location or region. The intensity of adoption could be associated with land size and age as influential factors in some cases. About 46.7% of cultivable land was found to be under agro-forestry.

Statistically, the most significant factor in influencing the adoption of agro-forestry technology was land size. Thus overcoming land constraint may have an impact on adoption, in the sense of increasing farmers' likelihood to adopt. Knowledge in terms of motivation by extension agents is also critical especially in the diffusion of the technology. Since the technology is labour intensive, where there is labour constraint the likelihood for adopting agro-forestry may decrease, hence a call for consideration of women's (the main contributors in adopting the technology) position focusing on day-to-day workload.

Risk factor was not measured using a well-recognized procedure. The factor should not be neglected since unwilling to take risk resulted from drought effect, animal browsing, pests and diseases and fire incidences was mentioned by the majority of the sample population as a major constraint pertaining to opt for agro-forestry.

Empirical evidence has shown that in the rural communities most of the environmental and some of the socio-economic problems, which are intended to solve, by themselves would be constraints to adoption of agro-forestry technologies. In the first place, some of the socio-economic factors influencing the adoption of agro-forestry practices for instance risk aversion, would seem to result from environmental factors. Problems such as soil erosion, over cultivation, high soil temperatures and decline in rainfall in the study area have been reflected in the poor performance of crops and trees. Risk aversion behaviour then does not imply to only agro-forestry in the sense of avoidance to planting certain important species of trees but also to crops whereby certain types of crops may be avoided due to inadequate rainfall and soil infertility. In the second place, limited land was found to hinder tree planting nevertheless agro-forestry is meant to increase productivity in such a scarce resource.

Capital was not included in any model for analysis since farmers rarely mentioned the factor as an important need for adoption. However, both linear and logistic regression models were found limited by the fact that the independent variables might have influences on each other. There also might be some cases where the dependent variables could influence independent variables; example adoption may have a positive influence on knowledge and perception of economic profitability. Thus, the extra procedures of analysis such as cross tabulations, frequencies, graphing and content analysis assisted in the identification of some hidden factors and contributed to a large extent in increasing the reliability of the models.

In summary therefore, if all the factors are viewed in a holistic context, risk aversion may be a leading constraint to adoption. Perceived economic profitability by farmers was so obvious in tree species preference, so, it can hardly be isolated from knowledge, adequate land and labour availability in encouraging the adoption of agro-forestry practices. Thus it would suffice to say that, if risk, appropriate extension service, land and labour factors are seriously taken into account in the current agro-forestry activities, then the number of trees per hectare might double in the next five years.

5.2 Recommendations

Basing on the results and implications of the study the following recommendations are made:

5.2.1 Management recommendations

Farmers' attitude: Farmers should value trees as equally important as crops and take the similar action for those who destroy farm trees.

Training: The institutions that are committed in promoting agro-forestry practices are encouraged to continue with farmer training, giving priority to women. There is a need to incorporate the aspect of gender equality in decision-making and household distribution of labour in training components.

Extension: Extension practitioners need to maintain motivation activities at least to a constant level or improved so as to keep the adoption graph raising.

Evaluation: Since VI AFP still has more time ahead for implementation, both annual and mid-term evaluations are recommended so as to point out any deficiencies and re-plan for improvement.

Land resource: The plans for MMAP would minimize land constraint and farmers' uncertainties so it is suggested these plans to be reconsidered starting with the improvement of social services in the new area, Bugwema.

Approach and linkage: A multisectoral approach is strongly advocated and linkage with governmental and various non-governmental organizations is needed to facilitate solutions for problems.

5.2.2 Research recommendation

The model: There is a need to test the procedure applied by Cary and Wilkinson (1997) in minimizing the limitation of logistic regression model.

Soil: it is suspected that soil in the study area is about to reach a critical zone stage. An investigation on this would be important so as to justify the role of soil improvers on such a severely degraded land taking into account that these species also need an initial energy for nitrogen fixation.

Pests and diseases: If cassava crop is left to deteriorate there might be a limited alternative for the lakeshore communities. Research is recommended on the status of cassava crop in relation to pests and diseases.

Improvement: The introduction of efficient water use technique is recommended and its effect be measured.

Trend: Research for determination of the trend will be important for improvement and learning purposes.

5.2.3 Policy recommendations

Security: There is a felt need to strengthen the National Environmental Policy focusing on herders' grazing habits and fire mismanagement by crop producers so that village leaders can be ensured with security when taking action.

Social services and infrastructure: Similar to farmers, extension staff who are based in the villages would need adequate social services like water and health as well as communication so that they can work efficiently.

Extension services: Appropriate agricultural and forestry extension services should be based at villages where the activities of the grass roots can easily be facilitated.

REFERENCES

Aidan, M. (2000). *Atlas Kwa Shule za Msingi Tanzania*. Macmillan Aidan, Dar es Salaam. 64 pp.

Altieri, M.A, (1991). How can we use biodiversity in agro-ecosystems: outlook on agriculture. *Journal of Biogeography* 20:15-23

Amacher, G.S., Hyde, W.F. and Rafiq, M. (1993). Local adoption of New Forestry Technologies: an example from Pakistan's Northwest Frontier Province *World Development* 21 (3): 445 - 453.

Anon (1998). *East Africa Rwanda and Burundi*: physical, political, climate, land use, minerals industry and people. Oxford University Press, Oxford.

Anon (2003). *2002 Population and Housing Census General Report*. Central Census Office, National Bureau of Statistics, President's Office Planning and Privatization, Dar es salaam. 203pp.

Anon (undated). *Mara Region Socio-economic Profile*. The Planning Commission Dar es Salaam and Regional Commissioner's Office Mara. 54 pp.

Balton, D. (1984). *Indigenous Agro-forestry in Latin America*: a blue print for sustainable agriculture. NRI-socio-economic series No. 6. Chattani, UK. 24pp.

Batz, F.J., Peters, K.J. and Janssen, W. (1999). The influence of technology characteristics on the rate and speed of adoption. *Agricultural Economics* 21:121 - 130.

Boahene, K. (1998). The challenge of deforestation in Tropical Africa: reflections on its principal causes, consequences and solution. *Land Degradation and Development* 9: 247 - 258.

Cary, J.W. and Wilkinson, R.L. (1997). Perceived profitability and farmers conservation behaviour. *Jornal of Agricultural Economics* 48 (1): 13-21.

Caveness, F.A. and Kurtz W.B. (1993). Agroforestry adoption and risk perception by farmers in Senegal. *Agroforestry Systems* 21:11-25.

CE/T Unit Musoma (2002). *Short briefing about the Vi Agro-forestry Project Musoma – Mara.* Unpublished document. VI AFP, Mara - Tanzania. 3 pp.

CRS – Kenya (1995). *Nyanja Agro-forestry Project evaluation report.* Unpublished document. The diocese of Musoma, Mara – Tanzania. 2 pp.

Epaphra, E. (2001). *Assessment of the role of women in agro-forestry systems: a case study of Marangu and Mamba, in Kilimanjaro region, Tanzania.* Sokoine Univiversity of Agriculture Morogoro, Tanzania. pp 35 – 66.

FAO (1991). *Household Food Security and Forestry.* An analysis of socio-economic issues. FAO, Rome, Italy. 147 pp.

FAO (1993). *Conservation of Genetic Resources of Tropical Forest Management.* Principles and Concepts. FAO, Rome, Italy. 105 pp.

FAO (1999). *Rural Poverty, Risk and Development.* FAO, Rome, Italy. 132 pp.

Feder, G., Just, R.E. and Zilberman, D. (1985). Adoption of agricultural innovation in Developing Countries: a survey. *Economic Development and Cultural Change* 31: 255-298.

Fernandes, E.C.M., Okting'ati, A. and Maghembe, J. (1984). The chagga homegardens: a multistoried agroforestry cropping system on Mount Kilimanjaro Northern Tanzania. *Agroforestry Systems* 2:73-86.

Ghadim, A.K.A. and Pannell, D.J. (1999). A conceptual framework of adoption of an agricultural innovation. *Agricultural Economics* 21:145-154.

Heathcote, G. (1992). Ghana acts on agro-forestry plan to protect land. *African Business 165: 36.*

ICRAF (1997). *Medium- Term Plan 1998-2000.* ICRAF Signal Press, Nairobi, Kenya. 77 pp.

ICRAF (2002). Agroforestry Technologies. [file://A:agroforestry technologies.htm] site visited in June 2002.

Jason, P. (1991). Nigeria Survey: environment. *African Business, 15: 39-41.*

Jere, (1995). *Analysis of the economic behaviour of small holder farmers: A survey of adoption of new bean varieties.* University of Malawi. Pp 19 – 27.

Kajembe, G.C (1994). *Indigenous Management Systems as a Basis for Community Forestry in Tanzania: A Case Study of Dodoma Urban and Lushoto Districts.* Tropical Resource Management Papers, Wageningen Agricultural University, The Netherlands. 194pp.

Kalineza, H.M.M., Mdoe, N.S.Y. and Mlozi, M.R.S. (2000). Factors Influencing adoption of Soil Conservation Tehcnology in Tanzania: a case study in Gairo. In: *Faculty of Agriculture (FoA) (1999). Agricultural Research Challenges for the 21st Century. Proceedings of the Fourth Annual Research Conference of Faclty of Agriculture.*(Edited by N. Hatibu et al.) 17th – 19th November 1999, Morogoro Tanzania. pp 76 – 84.

Kessy, J. F. (1992). *Socio-economic and policy aspects of existing environmentally sound land use techniques to the rural population: A case study of the intergrated agroforestry project in Legho Mulo – Tanzania.* University of Norway.

Kessy, J. F. and O'Kting'ati, A. (1994). An analysis of some socio-economic factors affecting farmer's involvement in agro-forestry extension projects in Tanzania. *Annals of Forstry* 2 (1): 26 –32.

King, R.N and Rollins, T.J. (1995). Factors Influencing the Adoption of Nitrogen Testing Program. *Journal of Extension* .33(4). [http://www.joe.org/joe /1995august /rb2.html.] site visited in November 2003.

Koutsoyiannis, A. (1977). *Theory of Econometrics*. Second edition. Macmillan Education Ltd; London, UK. pp. 281-284

Lapar, M.A. and Pandey, S. (1999). Adoption of soil conservation. The case study of Philippine uplands. *Agricultural Economics* 21: 241 - 256.

Lazaro E. A. Senkondo, E.M.M. Bakari, A., Kishebuka, S.R. and Kajiru G.J. (1999). The use of computer simulation to Assess the suitability of Rain Water Harvesting (RWH) technology interventions in Semi-arid Tanzania. *Tanzania Journal of Agricultural Sciences 2(2): 219-226.*

Lounela, L. and Lunkkanen, J. (1991). Energy and Everyday Life. In: Haarasilta, J., Hoim, A.S. Kairo-oja, J. Lissila, A., Lounela, L. and Moris, P. (Eds). *Energy Use and Planning in Tanzania.* Report of these Research and Training on Energy, Environment and Development. University of Tampere, Unit of Peace Research and Development Studies pp. 152 – 180.

Mbuya, L.P., Msanga,H.P., Ruffo, C.K., Birnie, A. and Bo Tengnäs (1994). *Useful Trees And Shrubs for Tanzania: Identification, Propagation and Management for Agricultural and Pastoral Communities.* Technical handbook No 6. RSCU/SIDA, Nairobi, Kenya. 542pp.

Michon, G and Mary, F. (1994). Conservation of traditional village gardens and economic strategies of rural households in the area of Bogor, Indonesia. *Agroforestry Systems 25:31-58.*

Mnkeni P.N.S. (1992). *Role of soil management in enhancing suitability of smallholder cropping systems in agro-economic systems of Tanzania. A Review.* Ecology and Development Paper No. 3. Center for Sustainable Development, Agricultural University of Norway. 46 pp.

Mowo, J. G. Floor, J., Kaihura, F.B.S and Magoggo J.P. (1993). (Eds). Review of Fertilizer Recommendations in Tanzania. *Part 2, Revised Fertilizer Recommendations for Tanzania. Soil Fertility Report No. F6.* National soil service. A.R.I. Mlingano Ministry of Agriculture Tanga, Tanzania. 71 pp.

Nair, P.K. (1993). *An introduction to Agroforestry.* Kluwer Academic Publishers. Dordecht. 500 pp.

Nowak, P. (1987). The adoption of Agricultural Conservation Technologies. Economic and Diffusion Explanations. *Rural Sociology* 52 (2): 208-220.

O'kting'ati, A. (1985). *An analysis of the Economics of Agroforestry in Kilimanjaro.* Sokoine University of Agriculture. 160 pp.

Owusu, D.Y. (1990). Experiences in agro-forestry*: ILEIA Newsletter* (6) 2:8-10.

Pell, A. (1999). Animal in agro-forestry in the Tropics. In: Buck L. (ed) *Agro-forestry in Sustainable Agricultural Systems.* National Academy Press, Washington D.C.

Rosheleau, D.E. (1988). Gender, resource management and the rural landscape: Implication for agro-forestry and farming systems research. In: *Gender Issues in Farming Systems Research and Extension.* (Eds). Schmink, M., Poats, S.V. and Spring, A. Westriew Press. Noolder and London. pp 149-169.

Rugalema, G. H., Johnsen, F. H., O'Kting'ati, A. and Minjas, A. (1994). The homegardem agro-forestry system of Bukoba district, North-West Tanzania. An economic appraisal of possible solutions to falling productivity. *Agroforestry Systems* 28: 227 – 236

Senkondo, E.M.M., Mdoe, N.S.Y., Hatibu, N., Mahoo, H. and Gowing, J. (1998). Factors affecting the adoption of Rain Water Harvesting technologies in Western Pare Lowlands of Tanzania. *Tanzania Jornal of Agricultural Sciences* 1 (1): 81 - 89.

Senkondo, E.M.M. (2000). *Risk Attitude and Risk Perception in Agro-forestry Decisions: The Case of Babati, Tanzania.* Mansholt Studies, Wageningen University. 204 pp.

Shiferaw, B. and Holden, S.T. (1998). Resource degradation and adoption of Land Conservation technologies in the Ethiopian Highlands: a case study in Andit Tid, North shewa. *Agricultural Economics* 18:233-247.

Walker, T.S. (1981). Risk and adoption of hybrid maize in El Salvador. *Food Research Institute Studies* 18 (1): 58-88.

Yaron, D., Dinar, A and Voet, H (1992). Innovations on family farms: the Nazareth region in Israel. *American Journal of Agricultural Economics* 74 (2): 361-69

APPENDICES

Appendix 1: Household questionnaire form

Name of enumerator......................................
Name of ward...
Name of village...
Household identification number.......................

PART ONE

Background information

1.1 Gender of household head
01 = Male
02 = Female

1.2 What is your marital status
01 = Single
02 = Married
03 = Divorced
04 = Widowed
05 = Others (Specify)..

1.3 What is your age?
≥ 40 = Old
< 40 = Young

1.4 Have you had formal schooling?
01 = Yes
02 = No

1.5 What is your level of education?
01 = No Formal education
02 = Adult education
03 = Primary education
04 = Secondary education
05 = Institution (Specify)...

1.6 Are you a resident in this village
01 = Yes
02 = No

1.7 What is your ethnic group

1.8 What is your occupation

1.9 What is the total number of family members in the household

1.10 Household composition*

No.	Sex	Age (yrs)	Level of education	Occupation

* Including female and male adults and children, dependants and all relatives living in the house

PART TWO

Land and its use

2.1 Do you possess any piece of land?
- 01 = Yes
- 02 = No

2.2 If yes, how much land do you possess (in acres)?

2.3 How did you acquire your land?
- 01 = Given by a clan
- 02 = Inherited
- 03 = Bought
- 04 = Rented
- 05 = Others (specify)..

2.4 What do you use your land for?

- 01 = Crop production
- 02 = Tree planting
- 03 = Both tree planting and crop production
- 04 = Animal production
- 05 = Renting
- 06 = All of the above
- 07 = Others (specify)..

2.5 What types of crops do you cultivate?

....

....

2.6 How do you demarcate your land

01 = By planting trees

02 = By planting sisal

03 = No demarcations

04 = Other (specify)...

2.7 If sisal is used or if no demarcation, can you give reasons

2.8 How much land have you allocated in each of the following

Use	Acres
Crop production	....
Tree planting	....
Crops and trees	....
Animal production	....
Renting	....
Others	....

PART THREE

Agro-forestry practices

3.1 What type of agro-forestry practices do you use

01 = Scattered trees in cropland

02 = Plantation crop combinations

03 = Shade trees in cropland

04 = Grazing under forest or scattered trees

05 = Animal production in woodland

06 = Tree home gardens

07 = Woodlots and other block planting of trees on farmland

08 = Wind breaks

09 = Shelterbelts

10 = Live hedges

11 = Living fences

12 = Woody strips and tree hedges

13 = Alley cropping

14 = Shifting cultivation

15 = Others (specify)

3.2 If you don't practice any agro-forestry, state the reason basing on your experience...

3.3 Which tree species are present in your farm and around home compound?

Species vernacular/ Scientific name	E/I	Number	Spatial arrangement	P/R	Uses

Key:
E = Exotic
I = Indigenous
P = Planted trees
R = Retained trees

3.4 For planted trees, what practice do you use?
01 = Tree seedlings
02 = Direct sowing

3.5 Why do you prefer any of the above?

3.6 Where do you obtain tree seedlings or seeds?
01 = Buying tree seedlings from village tree nursery
02 = Buying tree seedlings from outside the village
03 = From household tree nursery
04 = Buying seeds from elsewhere
05 = Given seeds and seedlings freely by an organization (Governmental/non governmental)
06 = Given seeds and seedlings freely by neighbours

3.7 Where did you learn and gather information on agro-forestry?
01 = Parents
02 = Radio and television
03 = Friends and relatives
04 = Seminars/workshops/study tour
05 = Reading magazines
06 = Extension services
07 = Pamphlets on agro-forestry practices
08 = Others (Specify)..

3.8 When did you start planting trees in your field/farm and at your home?

3.9 How many trees do you plant every year?

Number	Number of trees	No. in field	No. at home	Purpose
1991				
1992				
1993				
1994				
1995				
1997				
1998				
1999				
2000				
2001				
2002				

3.10a Is your household food sufficiency?
01 = Yes
02 = No

3.10b From which year give reasons...

PART FOUR

4.1 What kind of tree species would you prefer to plant and why?

4.2 Are the seeds and seedlings for the mentioned species available?

4.3 What kind of tree species are not of your preference and why?

4.4 Do you have these species in your field and why?

4.5 Are you familiar with tree planting principles?
01 = Yes
02 = No

4.6 Agro-forestry is economically beneficial in a long run?
01 = Strongly agree
02 = Moderately agree
03 = Agree
04 = Neither agree no disagree
05 = Disagree

4.7 What kind of agro-forestry products do you benefit?
01 = Fuel wood
02 = Fodder

03 = Poles
04 = Timber
05 = Fruits
06 = Local medicines

4.8 Have you ever sold trees from your field? Estimate price per trec and size

4.9 How much income did you earn in the last three year

Products	Income T.shs		
	2000	2001	2002
Crops			
Livestock and its products			
Tree and its products - Wood products - Non wood products e.g. fruits			
Other activities (specify)			

4.10 What is your source of capital for farm and agro-forestry practices?
01 = Loan
02 = Savings
03 = Assistance
04 = Dowry
05 = Others (Specify)...

4.11 In a short run it is too costly in terms of money to plant enough trees
01 = Strongly agree
02 = Moderately agree
03 = Agree
04 = Neither agree nor disagree
05 = Disagree

4.12 In a short run it is too costly in terms of labour to plant enough trees
01 = Strongly agree
02 = Moderately agree
03 = Agree
04 = Neither agree nor disagree
05 = Disagree

4.13 Planting trees is a very difficult task
01 = Strongly agree
02 = Moderately agree
03 = Agree
04 = Neither agree no disagree
05 = Disagree

4.14 Deforestation courses serious environmental and socio-economic problems
01 = Strongly agree
02 = Moderately agree
03 = Agree
04 = Neither agree no disagree
05 = Disagree

4.15 What kind of fuel source do you use for cooking?
01 = Firewood
02 = Charcoal
03 = Gas
04 = Electricity
05 = Kerosene
06 = Others (specify)..

4.16a If it is firewood, which tree species are mainly used
(i) ....
(ii) ....
(iii) ....
(iv) ....

4.16b If it is charcoal, which tree species are mainly used?
(i) ....
(ii) ....
(iii) ....
(iv) ....

1.17 Where do you collect firewood?
01 = Natural forests
02 = Farm trees
03 = Village woodlots
04 = Buying
05 = Others (specify)..

4.18 Where do you obtain charcoal for cooking purposes?
01 = Buying
02 = Charcoal burning (Specify source of trees for charcoal burning)

4.19 What is the distance from hone to firewood collecting point?
Give distance or specify duration for go and return trip

4.20 Who normally does the above-mentioned activity?
01 = Female adults
02 = Male adults
03 = Female children
04 = Male children
05 = Any combination of the above (specify).........................
06 = Others (specify)...

4.21 For how many days is firewood collected per week/month

4.22 What is the distance from home to the source of water for home consumption?
Give distance or specify duration for go and return trip

4.23 Who normally does the above-mentioned activity?
01 = Female adults
02 = Male adults
03 = Female children
04 = Male children
05 = Any combination of the above (specify).........................
06 = Others (specify)...

4.24 In your household how many people participate in farm activities?

4.25 In forestry activities who do the following

Activity	Female adult	Male adult	Whole family	Female adult and male adult	Female adult and hired labour	Female adults and children of both sex
Tree planting Tree management Tree utilization						

4.26a Is there any cultural belief that encourages or prohibits you from tree planting

01 = Yes
02 = No

4.26b If yes, state it/them..
....
....

4.27 Mention non-farm activities you are involve with
01 = Business
02 = Employed
03 = Fishing
04 = Craft making
05 = Others (specify)...

4.28 Indicate the source of labour for various farm activities
01 = Hired labour
02 = Family labour
04 = Any combination of the above (specify).........................
05 = Others (specify)...

4.29 Do you need permit to harvest/cut trees planted/retained in your farm? If yes, who gives permit?

4.30 Who in the household has tree tenure right?
01 = Female adults

02	=	Male adults
03	=	Female and male adult
04	=	Male adult and male children

4.31 Which tree species are preferred by women/men and why

	Tree species		Reasons
	Vernacular name	Scientific name	

4.32 What do you consider the main socio-economic constraints pertaining to tree planting in your farm?

4.33 Rank them according to their relative importance

01	....	06	....
02	....	07	....
03	....	08	....
04	....	09	....
05	....	10	....

4.34 What are your opinions on what should be done to overcome these constrain

*********THANK YOU VERY MUCH FOR YOUR COOPERATION**********

Appendix 2: Checklist

A: FORESTER

A1 Name of interviewer
Name of ward
Name of village

A2 Gender of the forester

A3 What is your age

A4 What is your level of education/area of specialization

A5 For how many years have you been working in this village?

A6 What types of agro-forestry practices are carried out in this village?
....
....
....
....

A7 What kinds of the tree species are commonly planted in the village?
....
....
....
....

A8 What are the sources of seeds and seedlings to villagers?

1 = From an organization (specify).................................
2 = Buy from village nursery
3 = Buy from outside the village (specify)...........................

A9 What kind of tree species do they prefer mostly and why

Tree species	Reasons
....	....
....	....
....	....
....	....
....	....

A10 What kind of tree species do you recommend and why?

	Tree species	Uses
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....

A11 How do farmers acquire knowledge on agro-forestry?

....

....

A12 Based on your experience, what do you think are the constraints pertaining to adoption of agro-forestry practices by farmers

....

....

....

....

***********THANK YOU FOR THE INFORMATION**********

B VILLAGE EXTENSION OFFICER

B1 Name of Interviewee...
Name of ward...
Name of village..

B2 Gender of the officer............................

B3 What is your age.................................

B4 What is your education level/area of specialization

B5 For how many years have you been working in this village?

B6 What kind of agricultural crops cultivated together with different tree species

Type of crops	Tree species
....	....
....	....
....	....
....	....

B7 What kind of tree species do you recommend as a proper combination with crops and why?

B8 How much land in average do farmers possess?

B9 What types of livestock do the farmers keep?
....
....

B10 Are there any tree species prohibited from being combined with certain agricultural crops?

01 = Yes
02 = No
Explain...
....

B11 Based on your experience, how can you compare production from agro forestry practices and that from non agro-forestry practices?

B12 What is the situation in regard to food security in the village

01 = recurrent food shortages

02 = permanently food sufficiency (specify from which year)

************THANK YOU FOR THE INFORMATION***********

Appendix 3: Calculations for the determination of actual sample size

TOTAL NUMBER OF HOUSEHOLDS IN EACH VILLAGE

Bukumi	Rusoli	Kome	Chitale	Bwanga	
323	399	360	463	305	
Total					**1850**

NUMBER OF TREES IN EACH OF THE SAMPLED HOUSEHOLD

248	237	120	33	74
250	15	67	57	25
26	172	122	56	51
126	280	34	29	50
146	234	60	20	46
5	54	60	33	257

AVERAGE NUMBER OF TREES IN EACH VILLAGE

133.5	165.33	77.16	38	83.83

THE VARIANCES

36	11607.87	1280.17	228	7439.77

THE STD

6	107.74	35.78	15.1	86.25

PROPORTIONS OF VILLAGE HOUSEHOLDS TO THE TOTAL HOUSEHOLDS IN THE STUDY AREA

0.1745946	0.215676	0.194595	0.25027	0.164865

PRODUCTS OF MEANS AND PROPORTIONS

					Overall Mean
23.3083784	35.65766	15.01492	9.51027	13.82062	
Total					**97.31185**

PRODUCTS OF VARIANCES AND PROPORTIONS

6.28540541	2503.535	249.1142	57.06162	1226.557	
Total					**4042.553**

PRETESTING SAMPLE SIZE 30

RATIO OF PRODUCT TO SAMPLE SIZE	134.7518		
STANDARD ERROR OF OVERALL MEAN	11.60826		

Without stratification standard error would be 15 resulting to a sampling error of 30 trees

SAMPLING ERROR	**23.21653**	**Trees**	**24%**
CONFIDENCE INTERVAL AT 5% PROBABILITY LEVEL	**74.09532**	**TO**	**120.5284**

SAMPLE SIZE AT ALLOWABLE ERROR OF 10% (9.7 TREES)

Products of variances and households of each village

11628	4631540	460861.2	105564	2269130	
Total					**7478723**

PRODUCT OF SUM AND TOTAL HOUSEHOLDS **1.38E+10**

Error, E=9.7trees, t=2, and total households, p=1850

80488644

F69+F73= **87967367**

F71/F76= **Sample size (n) would be** **157.2815**

Tree statistics in each village

Village	**Mean**	**Std**	**Variance**
Bukumi	**23.58**	**46.03**	**2118.761**
Rusoli	**66.65**	**79.89**	**6382.412**
Kome	**57.03**	**34.84**	**1213.826**
Chitale	**27.6**	**31.57**	**996.6649**
Buanga	**59.1**	**56.21**	**3159.564**
Total	**46.79**	**55.06**	**3031.85**

STRATIFIED OVERALL MEAN

4.11694054	14.37478	11.09773	6.90746	9.743514
Total				**46.24043**

CONFIDENCE LIMITS	**37.7**	TO	**54.7**

Appendix 4: Agro forestry tree species in % respondents and species planted/retained in the study area

Botanicacal name	Family	Common/Local name *Jita*[i]/Swahili[ii]/English[iii]	% of respondents	% of species	Remarks	Main uses
Acacia spp	***Mimosoideae***	Muhare(J) Mgunga(S)	2	<0.5	Indigenous	Fc, Fw, Fb, Nf, Sc, Fod, Tm
Acrocarpus fraxinifolius	***Caesalpinioideae***	Indian ash (E)	1	<0.5	Exotic	Fw, Tm, Bf, Bh, Om
Albizia amara	***Mimosoideae***	Mfachiro(J) Bitter albizia(E)	1	0.8	Indigenous	Fw, ch, Nf, Sc
Albizia lebbeck	***Mimosoideae***	Mkingu(S) Siris tree(E)	26	6	Exotic	Nf, Sc, Fw, Tm, Ch, Fod, Pl, Mul
Annona muricata	***Annonaceae***	Mstafeli(S) Soursop(E)	39	5	Exotic	Fd, Med, Om, Fp, Isd
Agave sisalana	***Agavaceae***	Katani,Mkonge(S) Sisal(E)	70	-	Exotic	Fb, Sr, Lf, S,
Azadirachta indica	***Meliaceae***	Muarobaini(S), Neem tree(E)	20	2	Exotic	Fod , Fw, Tm, Sh, Med, Om, Isd, Wb
Cajanus cajan	***Papilionoideae***	Mtendegwe(J), Mbaazi(S), Pigeon pea(E)	2	<0.5	Exotic	Fd,Nf, Si, Sc, Fw
Casuarina equisetifolia	***Casuarinaceae***	Mvinje(S), Sea pine(E)	1	<0.5	Exotic	Fw,Ch, Tm, Nf, Sc

[i] Jita has been represented by J
[ii] Swahili has been represented by S
[iii] English has been represented by E

Carica papaya	***Caricaceae***	Mpapai(S), Pawpaw(E)	41	5	Exotic	Fd, Med, Mt
Cedrella Odorata	***Meliaceae***	Cedrella(E)	39	20	Exotic	Fw, Tm, Fb
Citrus sinensis	***Rutaceae***	Mchungwa(S), Orange(E)	34	5	Exotic	Fd, Fw, Sh
Citrus limon	***Rutaceae***	Limao(S), Lemon(E)	5	<0.5	Exotic	Fd, Fw
Cassia siamea	***Caesalpinioideae***	Mchongoma(J), Mjohoro(S), Iron wood(E)	11	2	Exotic	Fw, Tm, Ch, Pl, Sc, Bf, Orn
Croton macrostachyus	***Euphobiaceae***	Broad leaved croton(E)	1	<0.1	Exotic	Fw, Pl, Tm, Th, Sc
Eucalyptus spp	***Myrtaceae***	Mkaratusi(S), Gum tree(E)	9	3.5	Exotic	Fw,Tm, Pl, Wb, Sh
Ficus benjamina	***Moraceae***	Mkuyu(S),	1	<0.5	Indigenous	Fw, Sh
Gliricidia sepium	***Papilionoideae***	Mexican lilac(E)	3	0.5	Exotic	Fw, Ch Nf, Si, Sc, Fod, Gm, Gfb, wb
Grevillia robusta	***Proteaceae***	Mgivea(S), Grevillea(E)	1	<0.5	Exotic	Sc, Fw, Wb,Bf
Jacara mimisifolia	***Bignoniaceae***	Mjakaranda(S), Brazilian rosewood Jacaranda(E)	1	<0.5	Exotic	Fw, Pl, Tm, Th, Carving, Bf, Sh, Wb
Khaya anthotheca	***Meliaceae***	Mkangazi(S) African mahogany(E)	5	2	Exotic	Tm, Fw, Sh, Orn
Leucina leucocephala	***Mimosaceae***	Mlucina(S) Lucaena	3	<0.5	Exotic	Si, Nf, Fw, Fod, Sh
Melia azedarach	***Meliaceae***	Mburumatare(J), Mmelia(S) Bead tree(E)	74	32	Exotic	Fw, Tm, Orn, Sh, Pl, Th

Milicia excelsa	***Moraceae***	Mvule(S)	3	<0.5	Indigenous	Tm, Fw, Ch, Sh, Orn, Mul
Mangifera Indica	***Anacardiaceae***	Mwembe(S) Mango(E)	34	5	Exotic	Fd, Fw, Sh, Doc, Bf, Orn
Manihot glaziovii	***Euphorbiaceae***	Mpira(S), Tree cassava(E)	8	4	Exotic	Fd, Sh, Orn, Sc, Fw
Mussa sapientam	***Musaceae***	Kitoke(J), Mgomba(S) Banana(E)	3	<0.5	Exotic	Fd, Ropes,
Psidium guajava	***Myrtaceae***	Mpera(S) Guava(E)	8	0.6	Exotic	Th, Fd, Sh, Md
Persea Americana	***Lauraceae***	Mwembe mafuta, mparachichi(S), Avocado Pear(E)	5	1	Exotic	Fd, Orn, Sh
Sesbania sesban	***Papilionoidea***	Mjujume(J), Sesbania, river bean(E)	11	3	Indigenous	Fw, Fod, Nf, Si, Sc, Fib, Sh, Pl, Mul
Syzygium cuminii	***Myrtaceae***	Zambarau(S), Jambolan(E)	2	<0.5	Exotic	Fd, Sh, Fw
Tectona grandis	***Verbenaceae***	Msaji(S), Burma teak	2	0.5	Indigenous	Tm, Fw, Pl
Terminalia catappa	***Combretaceae***	Mkungu(S) Bastard almond(E)			Exotic	
Terminalia mentalis	***Combretaceae***	Panga uzazi (S)	2	<0.5	Exotic	Tm, Fw, Orn

Appendix 5: Frequency distribution table for the date when a farmer started tree planting (n=147)

Year		Frequency	% respondents	Valid %	Cumulative %
Valid	1962	1	.5	.7	.7
	1970	1	.5	.7	1.4
	1972	1	.5	.7	2.0
	1974	6	3.0	4.1	6.1
	1975	3	1.5	2.0	8.2
	1976	1	.5	.7	8.8
	1979	1	.5	.7	9.5
	1980	4	2.0	2.7	12.2
	1982	1	.5	.7	12.9
	1984	2	1.0	1.4	14.3
	1985	1	.5	.7	15.0
	1986	1	.5	.7	15.6
	1988	1	.5	.7	16.3
	1989	2	1.0	1.4	17.7
	1990	8	4.0	5.4	23.1
	1991	10	5.0	6.8	29.9
	1992	5	2.5	3.4	33.3
	1993	2	1.0	1.4	34.7
	1994	3	1.5	2.0	36.7
	1995	5	2.5	3.4	40.1
	1996	5	2.5	3.4	43.5
	1998	10	5.0	6.8	50.3
	1999	21	10.5	14.3	64.6
	2000	33	16.5	22.4	87.1
	2001	15	7.5	10.2	97.3
	2002	4	2.0	2.7	100.0
	Total	147	73.5	100.0	
Missing	99	53	26.5		
Total		200	100.0		

Appendix 6: The results of linear regression analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.387[a]	.150	.131	86.8613

a. Predictors: (Constant), Time back when a farmer started tree planting(Yrs), Number of female adults(Labour), Farm size in hectares, Familiarity with tree planting principles(Knowledge)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	244562.7	4	61140.681	8.104	.000[a]
	Residual	1388259	184	7544.886		
	Total	1632822	188			

a. Predictors: (Constant), Time back when a farmer started tree planting,Number female adults(Labour) , Farm size in hectares, Familiarity with tree planting principles(Kowledge)

b. Dependent Variable: Rate of tree planting (trees/ha)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.545	16.489		.033	.974
	Number of female adults(Labour)	10.269	6.687	.108	1.536	.126
	Farm size in hectares	4.251	1.594	.189	2.667	.008
	Familiarity with tree planting principles (Knowledge)	44.569	14.082	.229	3.165	.002
	Time back when a farmer started tree planting(Yrs)	.291	.165	.123	1.767	.079

a. Dependent Variable: Rate of tree planting (trees/ha)

Appendix 7: The dependence of adoption on village

Village * Adoption if trees > 50 and non-adoption otherwise Crosstabulation

Count

		Adoption if trees > 50 and non-adoption otherwise		
		Non-adoption	Adoption	Total
Village	Bukumi	37	3	40
	Rusoli	23	17	40
	Kome	19	21	40
	Chitale	33	7	40
	Bwanga	22	18	40
Total		134	66	200

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.227[a]	4	.000
Likelihood Ratio	30.311	4	.000
Linear-by-Linear Association	4.500	1	.034
N of Valid Cases	200		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.20.

Appendix 8: Relationship between land size, age and adoption by village

Farm scale * Adoption If trees > 50 and non adoption otherwise * Village Crosstabulation

Count

Village			Adoption If trees > 50 and non adoption otherwise: nonen Adoption	adoption	Total
Bukumi	Farm scale	Small	35	2	37
		Large	2	1	3
	Total		37	3	40
Rusoli	Farm scale	Small	15	7	22
		Large	8	10	18
	Total		23	17	40
Kome	Farm scale	Small	15	9	24
		Large	4	12	16
	Total		19	21	40
Chitale	Farm scale	Small	27	6	33
		Large	6.	1	7
	Total		33	7	40
Bwanga	Farm scale	Small	16	6	22
		Large	6	12	18
	Total		22	18	40

Chi-Square Tests

Village		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Bukumi	Pearson Chi-Square	3.120[b]	1	.077		
	Continuity Correction[a]	.393	1	.531		
	Likelihood Ratio	1.931	1	.165		
	Fisher's Exact Test				.214	.214
	Linear-by-Linear Association	3.042	1	.081		
	N of Valid Cases	40				
Rusoli	Pearson Chi-Square	2.283[c]	1	.131		
	Continuity Correction[a]	1.415	1	.234		
	Likelihood Ratio	2.296	1	.130		
	Fisher's Exact Test				.200	.117
	Linear-by-Linear Association	2.226	1	.136		
	N of Valid Cases	40				
Kome	Pearson Chi-Square	5.414[d]	1	.020		
	Continuity Correction[a]	4.014	1	.045		
	Likelihood Ratio	5.602	1	.018		
	Fisher's Exact Test				.027	.022
	Linear-by-Linear Association	5.278	1	.022		
	N of Valid Cases	40				
Chitale	Pearson Chi-Square	.061[e]	1	.805		
	Continuity Correction[a]	.000	1	1.000		
	Likelihood Ratio	.063	1	.801		
	Fisher's Exact Test				1.000	.645
	Linear-by-Linear Association	.059	1	.808		
	N of Valid Cases	40				
Bwanga	Pearson Chi-Square	6.208[f]	1	.013		
	Continuity Correction[a]	4.718	1	.030		
	Likelihood Ratio	6.355	1	.012		
	Fisher's Exact Test				.024	.014
	Linear-by-Linear Association	6.052	1	.014		
	N of Valid Cases	40				

a. Computed only for a 2x2 table

b. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .23.

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.65.

d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.60.

e. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.23.

f. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.10.

Symmetric Measures

Village			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Bukumi	Interval by Interval	Pearson's R	.279	.261	1.793	.081[c]
	Ordinal by Ordinal	Spearman Correlation	.279	.261	1.793	.081[c]
	N of Valid Cases		40			
Rusoli	Interval by Interval	Pearson's R	.239	.154	1.517	.133[c]
	Ordinal by Ordinal	Spearman Correlation	.239	.154	1.517	.133[c]
	N of Valid Cases		40			
Kome	Interval by Interval	Pearson's R	.368	.144	2.439	.020[c]
	Ordinal by Ordinal	Spearman Correlation	.368	.144	2.439	.020[c]
	N of Valid Cases		40			
Chitale	Interval by Interval	Pearson's R	-.039	.148	-.240	.811[c]
	Ordinal by Ordinal	Spearman Correlation	-.039	.148	-.240	.811[c]
	N of Valid Cases		40			
Bwanga	Interval by Interval	Pearson's R	.394	.146	2.642	.012[c]
	Ordinal by Ordinal	Spearman Correlation	.394	.146	2.642	.012[c]
	N of Valid Cases		40			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Age of the farmer * Adoption If trees > 50 and non adoption otherwise * Village Crosstabulation

Count

Village			Adoption If trees > 50 and non adoption otherwise		Total
			nonen Adoption	adoption	
Bukumi	Age of the farmer	Less than 40 years	18	2	20
		More than 41 years	19	1	20
	Total		37	3	40
Rusoli	Age of the farmer	Less than 40 years	12	4	16
		More than 41 years	11	13	24
	Total		23	17	40
Kome	Age of the farmer	Less than 40 years	4	3	7
		More than 41 years	15	18	33
	Total		19	21	40
Chitale	Age of the farmer	Less than 40 years	17	3	20
		More than 41 years	16	4	20
	Total		33	7	40
Bwanga	Age of the farmer	Less than 40 years	9	9	18
		More than 41 years	13	9	22
	Total		22	18	40

Chi-Square Tests

Village		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Bukumi	Pearson Chi-Square	.360[b]	1	.548		
	Continuity Correction[a]	.000	1	1.000		
	Likelihood Ratio	.367	1	.545		
	Fisher's Exact Test				1.000	.500
	Linear-by-Linear Association	.351	1	.553		
	N of Valid Cases	40				
Rusoli	Pearson Chi-Square	3.342[c]	1	.068		
	Continuity Correction[a]	2.255	1	.133		
	Likelihood Ratio	3.449	1	.063		
	Fisher's Exact Test				.104	.065
	Linear-by-Linear Association	3.258	1	.071		
	N of Valid Cases	40				
Kome	Pearson Chi-Square	.316[d]	1	.574		
	Continuity Correction[a]	.021	1	.884		
	Likelihood Ratio	.316	1	.574		
	Fisher's Exact Test				.689	.441
	Linear-by-Linear Association	.308	1	.579		
	N of Valid Cases	40				
Chitale	Pearson Chi-Square	.173[e]	1	.677		
	Continuity Correction[a]	.000	1	1.000		
	Likelihood Ratio	.174	1	.677		
	Fisher's Exact Test				1.000	.500
	Linear-by-Linear Association	.169	1	.681		
	N of Valid Cases	40				
Bwanga	Pearson Chi-Square	.331[f]	1	.565		
	Continuity Correction[a]	.065	1	.798		
	Likelihood Ratio	.331	1	.565		
	Fisher's Exact Test				.750	.399
	Linear-by-Linear Association	.322	1	.570		
	N of Valid Cases	40				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.50.

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.80.

d. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3.33.

e. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3.50.

f. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.10.

Symmetric Measures

Village			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Bukumi	Interval by Interval	Pearson's R	-.095	.152	-.588	.560[c]
	Ordinal by Ordinal	Spearman Correlation	-.095	.152	-.588	.560[c]
	N of Valid Cases		40			
Rusoli	Interval by Interval	Pearson's R	.289	.147	1.861	.070[c]
	Ordinal by Ordinal	Spearman Correlation	.289	.147	1.861	.070[c]
	N of Valid Cases		40			
Kome	Interval by Interval	Pearson's R	.089	.157	.550	.585[c]
	Ordinal by Ordinal	Spearman Correlation	.089	.157	.550	.585[c]
	N of Valid Cases		40			
Chitale	Interval by Interval	Pearson's R	.066	.157	.406	.687[c]
	Ordinal by Ordinal	Spearman Correlation	.066	.157	.406	.687[c]
	N of Valid Cases		40			
Bwanga	Interval by Interval	Pearson's R	-.091	.158	-.563	.577[c]
	Ordinal by Ordinal	Spearman Correlation	-.091	.158	-.563	.577[c]
	N of Valid Cases		40			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Appendix 9:The results of Logistic Regression analysis

```
Total number of cases:        200 (Unweighted)
Number of selected cases:     200
Number of unselected cases: 0

Number of selected cases:                    200
Number rejected because of missing data:    13
Number of cases included in the analysis:  187


Dependent Variable Encoding:

Original        Internal
Value           Value
       0        0
       1        1

Dependent Variable..   ADOPTION   Adoption If trees > 50 and non
adoption otherwise


Beginning Block Number  0.  Initial Log Likelihood Function

-2 Log Likelihood   240.30024

* Constant is included in the model.


Beginning Block Number  1.  Method: Enter

Variable(s) Entered on Step Number
1..        QN1.10F   Female adults
           QN2.2     Farm size in hectares
           QN4.5     Familiarity with tree planting principles
           TIME      Time back when a farmer started tree planting
           QN3.10A   Sufficient food in the household

Estimation terminated at iteration number 4 because
Log Likelihood decreased by less than .01 percent.

 -2 Log Likelihood       199.287
 Goodness of Fit         181.259
 Cox & Snell - R^2          .197
 Nagelkerke - R^2           .272

                      Chi-Square    df Significance

 Model                    41.013     5        .0000
```

Block	41.013	5	.0000
Step	41.013	5	.0000

Classification Table for ADOPTION
The Cut Value is .50

		Predicted nonen Adoption	Predicted adoption	Percent Correct
		n	a	
Observed				
nonen Adoption	n	107	16	86.99%
adoption	a	37	27	42.19%
			Overall	71.66%

---------------- Variables in the Equation -----------------

Variable	B	S.E.	Wald	df	Sig	R
QN1.10F	.3438	.1797	3.6585	1	.0558	.0831
QN2.2	.1565	.0442	12.5428	1	.0004	.2095
QN4.5	1.3693	.4405	9.6617	1	.0019	.1786
TIME	.0027	.0047	.3209	1	.5711	.0000
QN3.10A	-.0524	.3526	.0221	1	.8819	.0000
Constant	-3.2232	.5681	32.1923	1	.0000	

		95% CI for Exp(B)	
Variable	Exp(B)	Lower	Upper
QN1.10F	1.4103	.9915	2.0059
QN2.2	1.1694	1.0724	1.2752
QN4.5	3.9326	1.6584	9.3251
TIME	1.0027	.9935	1.0119
QN3.10A	.9490	.4755	1.8939

Correlation Matrix:

	Constant	QN1.10F	QN2.2	QN4.5	TIME	QN3.10A
Constant	1.00000	-.50646	-.31454	-.53363	-.28733	-.18994
QN1.10F	-.50646	1.00000	.01375	-.16116	.04446	-.08925
QN2.2	-.31454	.01375	1.00000	-.06345	-.17129	-.16141
QN4.5	-.53363	-.16116	-.06345	1.00000	.15538	.02074
TIME	-.28733	.04446	-.17129	.15538	1.00000	-.01943
QN3.10A	-.18994	-.08925	-.16141	.02074	-.01943	1.00000