ROLE OF AGROFORESTRY PRODUCTS IN HOUSEHOLD INCOME AND POVERTY REDUCTION IN SEMI-ARID AREAS OF MISUNGWI DISTRICT, MWANZA, TANZANIA

BY

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ABSTRACT

Agroforestry practice like any other land use practice has been reported to produce different benefits and products, which enhance household incomes and reduce poverty. This study was conducted in order to examine the contribution of agroforestry products to total annual household incomes and poverty reduction in semi-arid areas of Misungwi district, Mwanza Tanzania. Research methodologies used included literature review, questionnaire surveys, discussion with key informants and personal observation. A sample of 127 households engaged in agroforestry and non-agroforestry practices was selected randomly from six villages for questionnaire survey. Data analysis involved preliminary PRA information analysis with the community right in the field, content analysis and SPSS computer program. Three well-being levels of households namely; rich, medium and poor were identified. Agroforestry participants were richer than non participants with extra income of Tshs 954 611 (760 US$) per year. The agroforestry technologies practiced in the area included woodlot (37.7%), boundary planting (4.0%), Ngitili (15.2%) and indigenous live fence (20.8%). Agroforestry products and benefits, mainly generated from woodlots included poles (80.0%), fuelwood (86.0), timber (92.0%) and thatch grasses (32.7%). In comparison wood products from agroforestry practices contributed only 5.5% to total annual household incomes to agroforestry households while agriculture practices contributed about 51% to both agroforestry and non-agroforestry participants. In the regression model, wood products was not statistically significant at $p<0.05$ but positively correlated to total annual household incomes while agriculture and livestock keeping were statistically significant at $p<0.01$. This study concludes that agroforestry practices in the district do not contribute much to the total annual household income because it is constrained by small amount of trees established and poor selling price. It is recommended that more extension services and support be provided to agroforestry participants and other

farmers in the district to accelerate national poverty reduction and meeting Millenium Development Goals.

DECLARATION

I, STEPHEN MANONI MADUKA, do declare to the SENATE of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted for award of a degree in any other University.

_____ _____

STEPHEN MANONI MADUKA Date

MSc. Forestry

The above declaration is confirmed

_____ _____

Prof. J. F. Kessy Date

Supervisor

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DEDICATION

I dedicate this dissertation to my beloved mothers Bertha, Salome and Asteria Maduka and my grandmother Mariana Maduka who laid down the foundation of my education with a lot of difficulties.

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LIST OF ABREVIATIONS AND SYMBOLS

AF	Agroforestry
CBO	Community Based Organization
FAO	Food and Agriculture Organisation of the United Nations

FRMP	Forest Resource Management Project
HASHI	Hifadhi Ardhi Shinyanga (Shinyanga Soil Conservation Project)
ICRAF	International Centre for Research in Agroforestry
IUCN	International Union for Conservation of Nature
KIMKUMAKA	Farmers' Centre for Environmental Enhancement and Ethical Agriculture
LZARDI	Lake Zone Agricultural Research and Development Institute
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza na Kuondoa Umaskini Tanzania (National Strategy for Growth and Reduction of Poverty)
MNRT	Ministry of Natural Resources and Tourism
MRHP	Mwanza Rural Housing Programme
NAFRAC	Natural Resources Management and Agroforestry Centre
NGO	Non-Government Organization
NSGRP	National Strategy for Growth and Reduction of Poverty
PRA	Participatory Rural Appraisal
PRS	Poverty Reduction Strategy
RIDEP	Regional Integrated Development Programme
SAUT	St. Augustine University of Tanzania
SPSS	Statistical Package for Social Science
TAFORI	Tanzania Forestry Research Institute
TDPG	Tanzania Development Partners Group
TOFNET	Trees On-farm Network
Tshs	Tanzania Shillings
UNDP	United Nations Development Programme
URT	United Republic of Tanzania

VEO	Village Executive Officer

CHAPTER ONE

1. INTRODUCTION

1.1 Background Information

Poverty can be defined as the state of the well being material deprivation that is related to hunger, living without decent shelter, education, mortality and morbidity, vulnerability and exposure to risk, no opportunity to be heard and powerless, leading to be pushed from potential areas by those who are powerful (Semboja, 1994; UN, 2001; Commission for Africa, 2005). In Tanzania it has been defined by including some socio-economic indicators of well being such as prevalence of malnutrition, illiteracy, poor quality water and housing, inadequate clothing, low level of food consumption and poor technology (URT, 2000; URT, 2005b).

Like other developing countries, Tanzania's rural population suffers varying degrees of income poverty, because incomes are lower and poverty is more widespread than the urban centres. For example, according to URT (2002; 2005c), incidence of poverty in rural areas is more experienced by 39% of households while the percentages in Dar es Salaam and other urban centres are about 18 and 26 respectively. Poverty income in rural areas is attributed to inappropriate and poor agriculture technologies, which mainly base on subsistence farming operating in small scale, influenced by unreliable rainfall and poor markets (Shechambo *et al.*, 1999; URT, 2002; Madulu, 2004; Garrity, 2004; Maghimbi, 2005). Thus, the achievement of national poverty reduction by 2025 and Millennium Development Goals (MDGs) in 2015 are expected to move quickly if rural income poverty decline is achieved by promoting alternatives approaches like agroforestry practices.

Agroforestry (AF) is among the forms of land use practice that has the role to contribute to households' income and poverty reduction in semi-arid areas because of its involvement in the management of natural resources in a sustainable way through integration of trees in farming systems. According to ICRAF (2002) and Garrity (2004), focus of AF is to regenerate land, to achieve food security, to generate income, build assets, and enhance ecological functions for sustainable livelihood.

The plant diversity in AF systems reduces risk of total crop failure, since the risk of losses from environmental hazards (pests & droughts) is spread among many species and varied land use practices (Ewel, 1986, cited by MacDicken, 1990). Trees and shrubs are deep rooted and have the capacity to survive even under severe drought conditions. During such conditions, with sound marketing strategies, a farmer can generate profits throughout the year by cutting few trees and sell them to earn extra income for sustenance (Dwived, 1992; FAO 2006). Basing on the importance of AF practice on restoring degraded lands and improving people's livelihood, the practice has been promoted and accepted widely and being evaluated by various programmes and projects (Baumer, 1990; Otsyina and Asenga, 1993; Otsyina *et al.*, 1996; Ngate, 2001; Ramadhani *et al.*, 2002; Bonifasi 2004).

In Tanzania, due to efforts that have been conducted in promoting AF interventions, there is evidence that tree resources under farmers' field have increased and farmers are benefiting basing on the decreasing of deforestation rate of natural forests reported. According to MNRT (2002), the rate of deforestation in natural forests in Tanzania is estimated at 91 000 ha per annum, differently from the one reported by MNRT (1998) of 130 000 to 500 000 ha per annum. This indicates that pressures in natural forests for various uses have decreased due to establishment of reasonable wood resources under farmers' field. The existence of wood resources and benefits obtained by the community necessitated further

studies in order to understand the role played by AF products to household income and poverty reduction.

According to Bonifasi (2004), a studies conducted in high potential areas of Lushoto district in Tanzania found that, in average farmers practising AF found to have higher incomes of Tshs 117 384.00 (US$ 117.4) per year than farmers not practising. Furthermore, the study conducted by Makawia (2003) and Msikula (2003) in Arusha and western Usambara Mountain in Tanzania reported trees from AF systems to contribute to about 16% and 9.1% respectively to annual household incomes. Since most of semi-arid areas including Misungwi District are under various social and environmental pressures and inadequacy of studies conducted, thus the study on the same aspect was necessary to evaluate the significance of the practice to the livelihood of farmers.

1.2 Problem Statement and Justification

Misungwi district is among the districts in semi-arid areas that are affected by severe land degradation in the country. In rural areas, people are still poor due to dependence on farming and livestock keeping with production at subsistence level and at the same time affected by erratic rainfall, droughts and poor markets (Shechambo *et al.*, 1999; National report, 2002; URT, 2003; Mbwambo, 2004; Garrity, 2004). Agroforestry practice as one of the promising land use form was introduced in Misungwi district after restructuring the Community Forestry Programme in 1987 for the purpose of meeting critical fuel wood and poles demands for domestic uses and sustained agriculture (Mnzava, 1980; Kaale, 1984; Shanks, 1990).

The new restructured programme advised every Tanzanian to plant five trees in a year and this was the beginning of individual tree planting which influenced sense of ownership

differently from the previous programmes based on communal or village woodlot ownership. Among others, restructuring of the programme included initiation of AF practices in farmers' field, in-situ conservation of natural forests and people's participation. Through participation, farmers were able to decide for themselves where, for what purposes and how trees could be established and used. Currently, the support of Kwimba Afforestation Project, Forest Resources Management Project (FRMP) and Tanzania Forestry Research Institute (TAFORI) has promoted reasonable AF technologies and products where farmers have started to realize reasonable benefits. This potential was noted earlier by Guggenberger *et al.* (1989), pointing out that establishment of trees through AF nearby Mwanza town could be beneficial because of the increasing demand of tree products.

Despite of the promotion of AF practices in various areas in the country and number of studies conducted to validate the performance and contribution of introduced AF practices to the livelihood of farmers, yet little has been done regarding documentation and quantification of AF products particularly in Misungwi district. According to a study by Ngate (2001), farmers who practised AF in Misungwi district had not realized any significant return because it was still too earlier to determine benefits. Furthermore, even for studies that quantified and reported promising results under farmers' management in other areas of the country to some extent were constrained by shortage of land, partial adoption or low priority and poor management (Otsyina *et al.*, 1997; Shalli, 2003; Bonifasi, 2004; TAFORI, 2004b). Yet for the realized contributions at household level to some extent have not been appreciated at national level in many countries (Garrity, 2004).

Therefore, study on similar aspects was important in order to further understand the contribution of the recently realized benefits from AF technologies in household incomes

and poverty reduction in semi-arid area Misungwi district. Furthermore, the existing factors in the district like land tenure, well-being levels, environment factors, management and type of AF systems could have different socio-economic influence on AF participation and household incomes if compared to other places studied. Therefore, understanding the extent played by AF in household income will contribute to further understandings of role played by AF in household incomes for semi-arid areas and also will serve as basis for suggesting strategies that will support and emphasize on promotion of AF interventions to play as a supplementary to conventional agriculture. Agroforestry interventions are expected to contribute to the achievement of national poverty reduction and Millennium Development Goals (MDGs) by 2025 and 2015 respectively, while the document will support in promoting the recognition of the role played by AF in the country's economy.

1.3 Objectives

1.3.1 General objective

The general objective of the study was to assess the contribution of AF products in household income and poverty reduction in semi-arid areas of Misungwi district, Mwanza, Tanzania.

1.3.2 Specific objectives

(a) To identify and assess various well-being levels of communities in the study area

(b) To identify the existing AF systems and technologies in the study area

(c) To determine various AF and non-AF products and compare their annual incomes.

(d) To determine the extent of contribution of AF products to total annual household cash income over the conventional agriculture in the study area.

1.3.3 Testing the hypothesis

H_o: Agroforestry products have no contribution to total annual household income in the study area

H_1: Agroforestry products have contribution to total annual household income in the study area.

1.3.4 Limitation of the study

During conducting this study, some setbacks were encountered. These included problem of farmers recalling the data or information. Data collection depended on the respondents' memory, especially on the quantity and incomes of products got annually from AF practices, historical, villages' and villagers' backgrounds. This required asking of some questions more than once in different ways and use of key informants to make farmers understand questions, get the information and provide answers precisely.

1.3.5 Conceptual framework

The conceptual framework for this study is grounded on the assumption that in the presence of factors of production like land, human resource, favourable climate, planting materials and education, with improved AF interventions, it is assumed that there will be more AF products and maximum return from land. With the good markets, AF products will contribute to a sustained income to the household annually. It is also assumed that, the higher the income and the more household involved in AF practices the better the household is positioned in meeting its basic needs (meeting poverty lines) than the household not involved. Ability in meeting basic needs lead to the improvement of household well-being, recognition and poverty reduction.

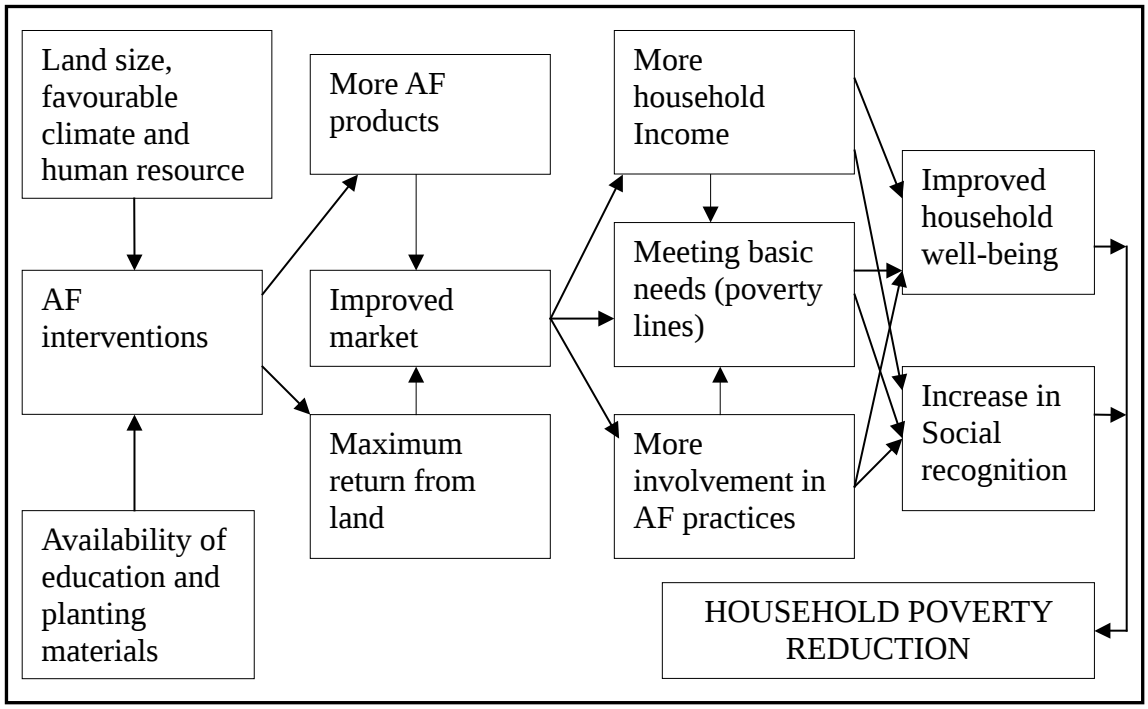

Figure 1: Conceptual framework of the study indicating the relationship between AF products and household poverty reduction

Source: Leakey *et al.* (2005) with modification.

CHAPTER TWO

2. LITERATURE REVIEW

Defining Poverty

Poverty is defined as the state of the well being material deprivation that is related to hunger, living without decent shelter, education, mortality and morbidity, fear for future and exposure to risk, no opportunity to be heard and powerless (UN 2001; Commission for Africa, 2005; Word Bank, 2007). In Tanzania it has been defined by including some socio-economic indicators of well being such as prevalence of malnutrition, illiteracy, poor quality water and housing, inadequate clothing, food insecurity and poor technology. To a large extent, these features have been used to identify poor and non poor individuals' households and societies or communities. An individual household or community found to be characterised by some or all of these features can be identified as being poor (Tanzania National Website, 2007).

A common method used to measure poverty is based on incomes or consumption levels. A person is considered poor if his or her consumption or income level falls below some minimum level necessary to meet basic needs. This minimum level is usually called the "poverty line". Thus, "minimum lines" denote basic food needs, based on specific assumptions about eating habits, nutritional requirements, and cost; and "upper lines" cover, in addition to such food requirements, other essential needs, such as clothing, housing, water, and health. What is necessary to satisfy basic needs varies across time and societies (URT, 2000; Word Bank, 2007). The poverty lines vary in time and place, and each country uses lines which are appropriate to its level of development, societal norms and values. It is commonly expressed in real terms, it is normally held constant in the short run, but is adjusted in the medium to long term to reflect the changes in the country's

priorities and level of development (Semboja, 1994). For instance in Tanzania, the food poverty line is 2200 kilo calories, the minimum necessary for adult per day and basic needs poverty line is one US dollar per day basing on the purchasing power parity exchange rate (URT, 2000).

Poverty and Environmental Degradation

There is a clear cause-and-effect relationship between poverty and environmental degradation, environmental degradation leads to widespread poverty and poverty is a habitual cause of degradation (MNRT, 1998). It has been observed also by Kabubo-Mariara (2003) and Maghimbi (2004) that, with population increase, normally the poor reside on marginal lands of rural areas of developing countries and through dependence of land for their livelihood; rural poverty and environmental degradation are closely related. For example, the poorest groups in rural Kenya are concentrated on low-potential lands (defined as resource-poor or marginal agricultural lands) where inadequate or unreliable rainfall, adverse soil conditions, fertility and topography limit agricultural productivity and increase the risk of chronic land degradation.

In Tanzania, about 80% of the population depends on land resources for their livelihood (TDPG, 2006). Socio-economic, climate and demographic factors make the people to put more pressure on these resources particularly natural forest for their livelihoods (USAID, 2004; Mbilea *et al.,* 2005). For instance, the total consumption of fuel wood in Tanzania is estimated at 43 million cubic meters per annum, while sustainable supply of fuel wood is estimated to be 19 million cubic meters per year indicating that this level of utilization is almost 126 percent higher than the sustainable supply (Madulu, 2004). According to FAO, (2001b) and MNRT, (2002), the rate of deforestation in natural forests in Tanzania is estimated at 91 000 ha per annum. This deforestation in the country has been leading to

reduction of biodiversity, wood products and soil fertility depletion making the majority of people remain poor due to low capacity of land productivity (Kaale, 1984; Swaminathan, 1987; Baumer, 1990; Salami *et al.*, 2002). Since the environment has been observed to be the victim for various pressures like overgrazing, over cultivation and overpopulation, its conservation has been observed to be important so that it can sustain and improve the livelihood of people.

2.1 Semi-aridity and Poverty

Semi-arid lands are those parts of the world where the rain is insufficient or barely sufficient for satisfactory crop growth in most years (Grove, 1977 cited in Shechambo *et al.*, 1999). According to Shechambo *et al.* (1999) and Mbwambo (2004), in Tanzania semi-arid area occupy about 45 and 80 percent of the country and receive a mean annual rainfall of 200-1200 mm. These include the region surrounding the new capital of Dodoma, the Lake Victoria Basin (Sukumaland) and Maasai territory stretching northward to the Kenyan border. However, information in semi-arid areas is still scanty because more studies have been concentrated in higher agricultural potential areas where there is high population dynamics and important source of revenues and livelihood for many people.

Semi-arid plains of Tanzania are characterized by unreliable rainfall, repeated water shortages, periodic famine and high pressure of overgrazing and of dry-land cultivation of marginal areas (Shechambo *et al.*, 1999) which tend to increase poverty incomes especially in rural areas. Rainfall is spatially and temporarily distributed with wide diversity of soils and water shortages. Insufficient length of fallow between cultivation periods led to the impoverishment of land whilst cattle grazing removed the last vestiges of vegetation cover. This situation was hastened also by agricultural programmes conducted in 1920s and 1930s

where large areas of land in semi-arid areas were cleared of bush and trees as part of tsetse fly and quellea bird eradication and cotton cultivation leaving the area tree less (Otsyina *et al.*, 1996). Even if there have been efforts to conserve these areas, regeneration and establishment have been gradual due to harsh weather existing in the region.

The major occupation for the people in the semi-arid areas of Tanzania includes agriculture, pastoralism and agro-pastoralism. However productivity in these areas does not result in more incomes and poverty income reduction to the majority of farmers because farming activities are affected by erratic rainfall, droughts and poor markets (URT, 2003; Maghimbi, 2004). Agriculture in Africa has been growing at the rate of 3% per year since the mid-1980s, but because of increasingly competitive world markets, Africa's market share in most agricultural commodities of small-scale farmers has bee declining affecting the sector in general (Garrity, 2004). Furthermore, agricultural production to large extent depends on rain-fed cultivation without proper soil and water management systems (Mbwambo, 2004). Therefore, improved technological adoption like AF practice in these areas is important so that it facilitates quick and more return from land, increasing income and reducing poverty to the majority of farmers. Since trees and shrubs are rooted deeply, they have the capacity to stabilize the soil and survive even under severe drought conditions. During such conditions, with reasonable marketing prices, trees can generate profits throughout the year whereby a farmer may cut and sell them to generate income for sustenance and livelihood improvement in contrast with a farmer not practising agroforestry (Dwived, 1992; Kamwenda, 2002; FAO, 2006).

Poverty Status and Reduction Strategy in Tanzania

Since independence in 1961, the Government of Tanzania has been preoccupied with three development problems: ignorance, diseases and poverty. To date, the population that live

below the national food poverty line is about 18.7%, while that living below the national basic needs poverty line is 35.7% (URT, 2005b). In rural areas, where the majority of farmers about 87% live, poverty is still overwhelming than in urban areas because of insufficiency of alternative resources, poor soil fertility and dependence on agriculture which operate at small-scale levels (URT, 2003; URT, 2005c).

Poverty reduction can be defined as the improvement of the well-being through meeting necessary human basic needs by meeting or exceeding poverty lines through improvement of consumption levels, adequate clothing and improved housing, education and reduction to vulnerability and exposure to risk. In this respect, the government of Tanzania is undertaking various initiatives toward poverty reduction and attainment of social and economic development (URT, 2002). This is in response to the World Bank, International Monetary Fund (IMF) and United Nations Development Programme (UNDP) support for poverty eradication in developing countries and the United Nations MDGs which aim halving the number of people whose income is less than one U$ per day by 2015 and eradicate abject poverty by 2025 (UNDP, 2001; FAO, 2001a; Swallow, 2005; Schreckenberg *et al.*, 2006).

In meeting this vision, the government developed and implemented a Poverty Reduction Strategy (PRS) from 2001/02 to 2004/05. It is also implementing a new five year National Strategy of Growth and Reduction of Poverty (NSGRP), commonly known in Kiswahili as Mkakati wa Kukuza na Kuondoa Umaskini Tanzania (MKUKUTA) that has been in operation since July 2005 (URT, 2005b). Agriculture being the leading sector in the country has been faced with a number of constraints like low productivity of land and environmental degradation. The integration of environment issues into the PRS and MKUKUTA process and the implementation of new institutional framework for

environmental management will support and sustain economic growth through sustainable use of environment.

Among the promising interventions is an AF practice, which through its multipurpose use, conserves the environment, increase wood resources, enhances households' income, contribute to poverty reduction in rural areas and conservation of natural forests. Enhanced tree-based systems and improved tree product marketing have the potential to address key aspects of rural poverty, child malnutrition, poor access to conventional health care, national tree product deficits (especially timber), inequitable returns to small-scale farmers from tree product marketing and lack of enterprise opportunities on small-scale farms (Garrity, 2004).

Agroforestry Systems and Technologies

A system is defined as a group of associated elements forming a unified whole and working together for a common goal. For example, a farm is an agricultural system composed of crops, livestock and trees managed in diverse spatial and temporal arrangements, subject to biophysical and socioeconomic conditions, to satisfy the household's objectives and priorities. There are several AF systems on this farming system and each can be described in functional; means management of resources like input levels used, technological and economic input and output levels achieved both in physical and or economic terms and structural means basic resources such as edaphic, biotic, abiotic, or economic resources involved (FAO, 1992).

Thus, AF can be defined as a dynamic, ecologically based land use system with deliberate retention or introduction of mixture of trees with crops, or livestock or both in a spatial arrangement, rotation or both in the agriculture landscape with an effort to optimize

positive interactions in order to sustain production for increased social, economic and environmental benefits (MacDicken and Vergara, 1990; Nair, 1990; Young, 1997; ICRAF 2000; FAO, 2006).

The term AF is fairy new but the practice is not new, it is an age-old based on vast store of indigenous knowledge developed by farmers since the dawn of agriculture (MacDicken and Vergara, 1990; ICRAF, 2000). Nowadays, it has been developed as a science that promises to help farmers increase productivity, profitability and sustainability of productions on their lands. Thus, AF simply is a means of managing land or using land that combines with agricultural (i.e. land use system) or horticultural crops or livestock or fish or bees (i.e. subsystem), together with the environmental factors of climate, soils and landforms (MacDicken and Vergara, 1990).

An AF system can be considered as a type of land use that is specific to a locality and described according to its biological composition and arrangement, level of technical management, and social and economic functioning (Nair, 1990; Young, 1989). Agroforestry by using its key features together with the pattern in which they are arranged on the landscape, make it possible to describe and classify the various pattern into different agroforestry systems and technologies (Dwivedi, 1994). Key features include land use systems and practices, presence of AF components (wood perennials, herbaceous crops and animals), ecological and economic interactions and how AF components are arranged in spatial or temporal sequence on the same land management to promote mutual and beneficial co-existence. According to Dwivedi (1994), several AF systems are old, others have been modified over the years and some retain their form to a considerable extent. It may involve the innovations or improvement, usually scientific interventions that can be applied to advantage in management of the system or technologies concerned. According

to Nair (1990), AF system classification includes, agrosilvicuture (agrosilvicutural system), silvopasture (silvopastoral system), agrosilvopasture (agrosilvopastoral system), aquosilviculture (aquosilvocultural system), and aposilviculture (aposilvocultural system). In the context of this study, agrosilvicutural and ailvopastoral systems are the dominant AF systems in the study area.

2.1.1 Agrosilvicutural systems

Agrosilvicuture includes all systems, which integrate wood perennials with agriculture crops on the same land simultaneously or alternatively. Different component structures and management on the landscape lead for other subdivision such as subsystems or technologies like mixed intercropping/relay/rotational woodlots, live fence and boundary planting (Young, 1989; Nair, 1990).

2.1.1.1 Woodlots

According to Nshubemuki (1998), the term “woodlots” means a near replica of wood vegetation assortments in smallholdings. It is a tract of land of any size and shape that contain naturally occurring or planted trees (Ramadhani *et al.,* 2002 cited by TAFORI, 2004b). Therefore, woodlot is the mature stand of trees with no further intercropping; conserved for multiple benefits like woodfuel, poles, thatch grasses, fodder, hoe handles, oxen yokes, timber and honey while also restoring the soil fertility. According to FAO (2004) woodfuel is all types of biofuels from trees and shrubs grown in forest and non-forest lands, including on-farms. The term includes fuelwood and charcoal derived from silviculture activities such as thinning, pruning and harvesting such as tops, roots and branches.

Sometimes establishment of woodlots may go through various phases from establishment, fallow and post-fallow alternating with crops; a practice termed as rotational woodlots. According to Ramadhani *et al.* (2002) and National Agroforestry Steering Committee (NASCO) (2006), rotational woodlots involve alternative phases of woodlots and crops where three phases take place. First phase entail a tree establishment phase (2 – 3 years) where trees are planted with crops; second phase involve a tree fallow phase where there is no more intercropping, grasses and bushes are allowed to regenerate and a third phase is post fallow where trees are harvested and cropping start again. For tree species that do not coppice at post-fallow or re-cropping phase, new tree seedlings are established and the cycle starts again. Therefore, rotational woodlot is a low cost AF option that involves alternating arable crops with multipurpose trees on the same piece of land over time (Otsyina *et al.*, 1996). A Multipurpose tree is one grown or conserved with the purpose of providing more than one significant contribution to the production or services to the community (Wood and Burley, 1991). The commonly used wood perennials in woodlots are arranged in square or rectangular in which the trees/shrubs in rows or columns spaced equally or unequally depending on the purpose of the farmer. The commonly used tree species in woodlots are exotics rather than indigenous species.

However, the idea of rotating has not been practiced in some places like in semi-arid areas of Shinyanga, Tanzania. Rotational woodlots farmers in Shinyanga felt better to conserve their fields for Ngitili or woodlots for production of fodder, poles, tree seeds and firewood rather than clear felling and re-cropping again (TAFORI, 2004b). This indicates that, the technology delivered to farmers can undergo innovation depending on farmer's needs and interest. Therefore, from the woodlots, farmers can obtain different benefits for domestic uses and income generation, all of which contribute to improvement of livelihood.

2.1.1.2 Boundary planting

The boundary site by definition implies a special situation with respect to land and tree tenure (Rocheleau *et al.*, 1988). This is AF technology in which, the wood perennials (trees or shrubs) are planted along the farm boundaries to obtain various wood products and for demarcation to avoid conflict with neighbouring farmers. Also, trees may be planted on the windward sides as windbreaks to protect crops against strong winds. In semi-arid areas, this practice is adopted most by farmers who have shortage of land.

According to Rocheleau *et al.* (1988), boundary planting may be widely or closely spaced, in single or multiple lines. However, the common form of boundary planting consists of a single line of widely spaced trees and shrubs. Depending on the tree species availability, along the boundary, it may be possible to combine with timber, firewood or fruit trees for profit maximization.

2.1.1.3 Live fence

These are lines of wood perennials planted closely around a land of management unit of herbaceous crops, livestock or homestead with protective purposes or privacy. In Central America live fences are used in delineating crop fields, pastures, and farm boundaries and forming elaborate networks of tree cover across rural landscapes (Harvey *et al.*, 2005). It is also the most used land use system in many communities in Africa for controlling movement of animals and checking winds speeds (Rocheleau *et al.*, 1988). Live fences may also form livestock driveways and enclosures of separate fields, which are in different rotations of crop or pasture management (paddocks).

Live fences should have the property of growing closely, roughness or thorniness and coppicing after cuts or trims. Therefore, trees or shrubs are planted close together in one or

more rows. In semi-arid areas, species mostly used in this technology is *Euphorbia tilucalli* because it grows and establish easily through cuttings (Rocheleau *et al.,* 1988). Thus, if the live fences are managed properly can play an important role in resource management and agriculture development.

2.1.2 Silvopastoral systems

Silvopastoral system is a land management system, which combines woody plants with grasses and other herbaceous fodder plants. The animal in this system is a dominant feature. Extensive silvopastoral systems on rangeland, usually involve the selective protection and management of naturally occurring trees and shrubs of particular value to animals (Rocheleau *et al.,* 1988). In the study area, a silvopastoral subsystem or practice exists and is an indigenous knowledge of natural resource management known as Ngitili.

2.1.2.1 Ngitili practice

“Ngitili” is a Sukuma word meaning enclosure. It is an indigenous knowledge commonly practiced in Shinyanga and Mwanza regions in Tanzania mainly for dry season grazing. The practice has been evaluated and confirmed to meet sustainable levels of production of dry-seasonal fodder supplies, food security and mitigation of land degradation basing on FAO criteria (Kamwenda, 2002).

The Ngitili is established by either village government through village meeting (for communal Ngitili) or individual farmers (for private Ngitili) who decide where to put the reserves by closing the area in order to allow for sufficient development of pastures. During fodder shortage period, especially during the dry season when free grazing areas are depleted, the Ngitili is opened bit by bit to allow animals to feed (Kamwenda, 2002; Mlenge, 2004). To make sure that closed areas are respected, traditional by-laws are used

to punish any one who does not abide to the management plan for the reserve. According to Kamwenda (2002), these customary institutional arrangements have been important in contemporary natural resource management in the area and thus contribute mostly to the successful management of the Ngitilis to provide their potentials. Potentials of Ngitilis base on their products for domestic use or income generation, which contribute to improvement of livelihood of households (Mlenge, 2004). Products include fodder, grasses for thatching, fuelwood, building poles, honey and indigenous fruits. Therefore, Ngitili practice plays a role in contributing to poverty reduction for participating farmers in semi-arid areas.

Agroforestry Products and Poverty Reduction

Reduction of poverty and sustenance of economic growth through sound and equitable environmental management has been emphasized by various documents (MNRT, 1998; Cooksey and Likwelile, 2002; URT, 2005b) and also by international organizations and Commission for Africa (Baumer, 1990; FAO, 2001a; ICRAF, 2004; Commission for Africa, 2005). However, poverty reduction can be achieved by involving various sectors for a certain community to develop. Forests and trees as alternative crops if used sustainably can help to reduce poverty in rural and semi-arid areas. Incorporating trees into farming systems by using agroforestry practices leads to greater prosperity at the farm level. Thus, trees on-farm provide farmers with products such as lumber, building poles, firewood, animal fodder, fruits and medicines which can be used directly or sold to earn extra income (ICRAF, 2000; ICRAF, 2004; TAFORI, 2004a&b; TOFNET, 2005; NASCO, 2006; FAO, 2006) in additional to conventional agriculture and off-farm incomes.

According to Bonifasi (2004), studies conducted in high potential areas of Lushoto district in Tanzania show that, in average farmers practising AF were found to have higher

incomes of Tshs 117 384.00 (US$ 117.4) per year than farmers not practising. On other hand, study conducted by Makawia (2003) and Msikula (2003) found that trees from AF systems found to contribute about 16% and 9.1% respectively to annual household incomes, the income that was used to purchase food or investing in agriculture. This concurs with observations by USAID (2004), that forestry sector contribute heavily to the Tanzanian economy with a 10% to 15% share of the country's Gross Domestic Product (GDP) from its forest products. Trees provide around 75% of building materials, 100% of indigenous medicinal and supplementary food products, and 95% of Tanzania's energy.

Furthermore from the study conducted on indigenous practice of natural resource conservation (Ngitili) in Shinyanga, the practice gave additional benefit estimated at Tshs 14 046.00 (US$ 11.06) per person per month which was higher than the national average consumption per person of Tshs 8500 (US$ 6.7) (MNRT and IUCN, 2005). These results indicate that, the forest sector and AF practice if given due weight have a role to play in contributing to annual total household income and achievement of MDGs by 2015 and eradicate abject poverty by 2025 in Tanzania.

2.2 Community Forestry Programme and Agroforestry Practice in Misungwi

The initiation of Community Forestry Programme in rural areas after Arusha declaration in 1967/68 by the Government of Tanzania (Mnzava, 1980; Kaale, 1984) marked various efforts in Misungwi District toward meeting critical fuel wood and poles demands for domestic uses as well for combating severe land desertification. For instance, farmers in rural area used sisal poles for construction, corncobs, cowdung cotton, *Euphorbia tilucalii* and sorghum stalks for cooking (Guggenberger *et al.*, 1989). The use of crop residues and cow dung also accelerated soil fertility depletion in farmers' fields. Thus, the programme which was supported by Regional Integrated Development Programme (RIDEP) in 1970s,

emphasized tree planting through schools and establishment of village or communal woodlots. According to Shanks (1990), the overall performance of the programme, especially for communal/village woodlots was not encouraging; the majority of successful woodlots which are seen even today belonged to schools and other institutions. Further restructuring of the programme was found to be the solution to accelerate tree planting and conservation.

The Community Forestry Programme was restructured in 1987 by formulating new strategies. It involved advising every Tanzanian to plant five trees in a year. This was also the beginning of individual tree planting which influenced sense of ownership differently from the communally or village owned trees. Basically, restructuring of the programme involved decentralization of nurseries, encouraging raising bare rooted seedlings or using locally available materials of potting, initiation of agrosilvopastoral (AF practices) and conservation of natural forestry (in situ conservation), all of which were achieved by involving people (participatory). Through participatory approaches, farmers were able to decide for themselves where, for what purposes and how trees could be established. During that period, the Non Government Organizations (NGOs) were given also the mandate in the work plan for Forestry Division. Therefore, numbers of NGOs including Kwimba Afforestation Project were able to initiate AF practices in farmers' field through participatory methods.

The Kwimba Afforestation Project which operated in Misungwi and Kwimba districts was initiated in 1990s. It largely emphasized household tree planting by using abandoned village or communal farms known as "*bega kwa bega*". In addition to this offer, farmers were encouraged also to establish their privately owned farms. According to Shanks (1990), establishment of communal farms involved the transfer of a parcel of land held

individually or communally under customary law, to collective ownership under the new village regulations. In the communal farm, individual farmers were allocated a piece of land where they were advised to practice AF by intercropping trees with crops and after tree or woodlots establishment they were given title deeds. In the district, the project operated in some villages that were severely defforestated, including villages studied. During the project period, management of trees was done by individual farmers while protection against livestock was done by the project. Recently, management and protection is under farmers because the project has phased out. To date, farmers are benefiting from the established AF systems in the District.

However, in the district, there have been also various interventions provided by various projects and research institutions like TAFORI, NAFRAC, FRMP and Lake Zone Agricultural Research and Development Institute (LZARDI) which have been scaling up of best practices of environmental conservation to extension officers and farmers.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Study Area Description and Geographical Location

The study was conducted in Misungwi district, in Mwanza region Tanzania, where AF interventions were promoted by the government, NGOs and Community Based Organization (CBOs). The district environment was severely degraded and problems of fuelwood, poles and poverty to rural people increased. Thus initiation of tree planting and AF promotion programmes intended to increase the availability of tree resources that could lead to improved rural livelihood in the district.

3.1.1 Geographical location

Misungwi district was established by the act of parliament in July 1995 after being excised from Kwimba district. It lies in northern part of Tanzania at latitudes 2^0.35' to 3^0.15' South of Equator and longitudes 32^0.45' to 33^0.15'East of Greenwich. It is among the eight districts of Mwanza region with a total area of 2 112 km^2, of which 175 km^2 is water and 1 949 km^2 is land. It is bordered by Mwanza and Magu district to the North, Kwimba district to the East, Shinyanga region to the South and Geita and Sengerema districts to the West (URT, 2003).

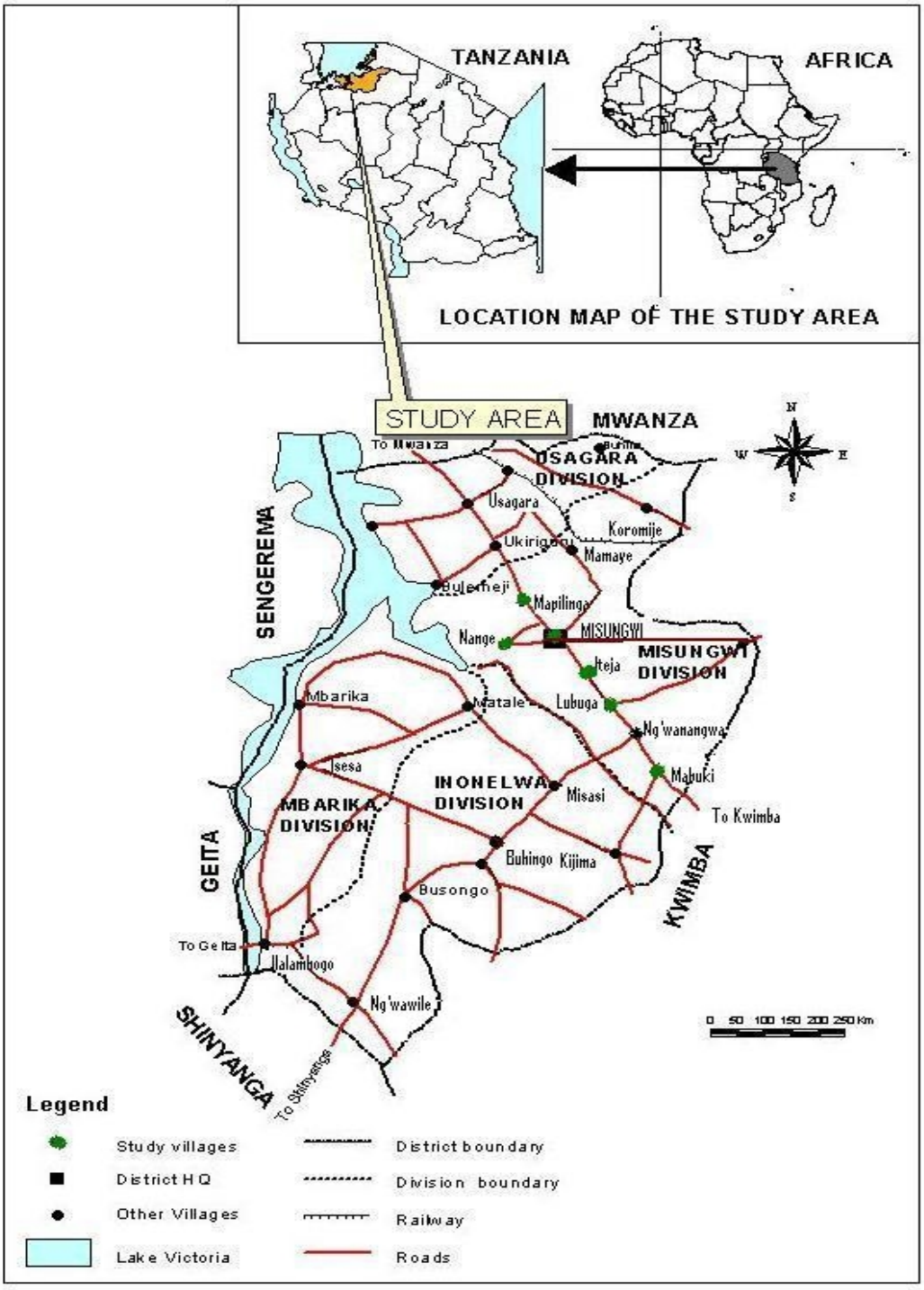

Figure 2: A map of Misungwi district, in Mwanza indicating study areas.

Source: Ndulu, (2004) with modification.

3.1.2 Climate

The district lies within the semi-arid zone, which is characterized by bimodal, unreliable rainfall between 700 – 1000mm per annum (URT, 2003; Ndulu, 2004), beginning in October and ending in April/May. Rainfall is erratic and poorly distributed with high variability within and between seasons. The rainy season is characterised by short dry spells, which are often detrimental to crop production. The mean and maximum temperatures range from 18^0C and 30^0C.

3.1.3 Relief, soils and natural vegetation

The district is situated at altitudes ranging from 1000 to 1500m above sea level predominated by sand and clay soils in some places. The sand soils exist in upper areas while clay soils occupy lower plains. Sand soils in upper areas are relatively of poor fertility and low water retention capacity and clay soils which are normally predominated by black cotton soils in lower flat plains are naturally fertile. The main natural vegetation is grassland with scattered bushes and acacia trees. The remaining patches of natural forests in conserved areas are still under threat of encroachment (Ndulu, 2004).

3.1.4 Population and socio-economic activities

The population of Misungwi district is 257 155 with the density of 132 per km^2 and average size of 6.4 persons per household and annual growth rate of 2.1 (URT, 2003; URT, 2005a). According to Ndulu, (2004), 92% of the population live in rural areas while 8% live in trade centres. The socio-economic activities of the population in the District are operated under subsistence farming, these include farming, livestock keeping and fishing and cash crops are cotton, paddy and chick pea/yellow gram (URT, 2003). Other grown crops are maize, millet, cassava and green gram. The major ethnic group is Sukuma.

3.2 Methods of Data Collection and Analysis

3.2.1 Data collection

Agroforestry and tree planting programme took place in farmers' fields and in communal or village lands where the farmers owned woodlots. Therefore, primary data collected based on the AF and non-AF participation and supplemented with secondary data as explained by the following sections.

3.2.1.1 Primary data collection

The primary data collection was carried out in three phases, namely reconnaissance, PRAs and questionnaire surveys.

(a) Reconnaissance survey

Prior to the main survey, villages under study were visited for self-introduction to the village leaders, making schedules for the PRAs and to be acquainted with the villages' environment. At the same time, AF participants were identified using group leaders while non-AF participants were identified using village register for wealth ranking. During the survey, both AF and non-AF participants' questionnaires were pre-tested for further improvement (Appendix 1 and 2).

(b) Formal surveys and PRAs

In order to solicit socio-economic information both for AF and non-AF farmers, household questionnaires with both open and close-ended questions were employed (Appendix 1 and Appendix 2). Among others, information collected included household size, land size, type of AF technologies practised, number of planted trees, number of poles sold, income from AF and non-AF and factors hindering AF

adoption. The head of the household was the targeted respondent for the interview. However if the head was absent another household member was allowed to respond on behalf.

Wealth ranking and historical trends as among of the PRA tools used for research at community level; they were selected and applied to determine well-being or poverty classes and historical background of the study area. Poverty analysis using community criteria was done in the study area in order to determine existing well-being classes and their relationship with the ability of farmers to participate in income generating activities including agroforestry practices.

Focused group discussions using key informants were employed to facilitate data collection in the area. According to Katani (1999), key informant is an individual who is accessible, willing to talk and has great depth of knowledge about issues in question. In the study area, key informants included few representatives in each village who knew their fellows and village historical background very well. Focused group discussion involved a composition of middle aged and elders of both males and females. With the aid of villages' roster and checklist (Appendix 3A) AF and non-AF participants were grouped into well-being classes.

In order to get an overview of the adoption trend, market potential and sustainability of AF practice in the area, surveys using checklist (Appendix 3B) were conducted involving Village Executive Officers (VEOs), Division Forest Extension Officers and District Natural Resources Officer. The VEOs were interviewed to understand if there are any measures and suggestion for further promotion of AF practice both in AF and non-AF villages. Division and District officers, in among other things, were

contacted in order to understand the existing potential markets of AF products and any current efforts done by individual farmers, NGOs, CBOs or Institutes pertaining on future promotion of AF practices.

(c) Sampling procedure for questionnaire surveys

A multi-stage sampling technique was used, where two wards in the district were purposely selected. From each of the two wards which were Misungwi and Igokelo, four and two respectively villages were selected purposely basing on the AF and non-AF participation making six villages which were Iteja, Lubuga, Misungwi, Mabuki, Nange and Mapilinga.

Sampling units of the study were households that were selected randomly basing on AF and non-AF participation. The recommended initial random sample size for data collection is 5%, however depending on the size of population; the size can be increased up to 10% in order to get a meaningful sample. Basing on this argument, a sample size of 10% for AF participants and all non-AF households in non–project villages was applied. From the sampling process a total of 76 AF and 51 non-AF households were included in the survey.

3.2.1.2 Secondary data collection

Secondary data collection relating with AF practices and AF products in relation to households income and poverty was done through literature search through libraries, internet and various reports to identify gaps to be covered. It involved also contacting different authorities like the District Natural Resource Officer in order to get the background information of the District.

3.2.2 Data analysis

This section involved:

- PRA data analysis
- Content analysis
- Analysis of data from questionnaire survey
- The linear regression analysis

3.2.2.1 PRAs data analysis

PRA data analysis was done with assistance from the community while in the field and the information obtained communicated back to farmers for authentication and custody.

3.2.2.2 Content analysis

Group discussion with key informants, personal observations and informal discussions, were analysed using content analysis. According to Stemler (2001), it is a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding. It is a technique for making inferences by objectively and systematically identifying specified characteristics of messages. Thus, the recorded dialogues between forest extension officers and VEOs and personal observations were broken down into meaningful themes where inferences were made.

3.2.2.3 Questionnaire data analysis

Prior to data analysis, data was coded and entered into a computer. Qualitative and quantitative data was analysed using the Statistical Package for Social Science (SPSS 11.5), where frequency tables and descriptive statistics were obtained.

3.2.2.4 The linear regression analysis

By using SPSS, some of the quantitative information obtained from the questionnaire surveys were used to predict whether or not the dependent and independent variables were significantly related by using the linear regression model. According to Kessy (1992), linear regression is normally used because is easier to handle. Therefore, the ordinary least squares were employed in calculating the regression equation.

(a) The linear regression model and hypothesis testing

Defining the dependent and independent variables was important for developing the linear regression model and hypothesis testing. The dependent and independent variables were defined as follows:

ATTHHI =The annual total household cash income. This was termed as the dependent variable because it was hypothesized to be influenced by various farming systems operated by the farmer like agriculture, livestock keeping and agroforestry practice. The more the household is involved in various income generating activities the more the household will have higher total household income for livelihood improvement.

AMTRE = Amount of trees planted. It is hypothesized that the more the trees planted in AF technologies by the households, the more they could spend for household use and sell to earn extra income than households without trees components in their fields.

CRHAR= The amount of crops harvested. Agriculture is the mainstay of the majority of farmers in rural areas. The hypothesis was that more crops

harvested by the household the more the household was food secured and had the possibility of increasing income through sale of extra crops for livelihood improvement.

LIV = Amount of livestock kept. Customarily, livestock keeping is regarded as safety net to various hazards and emergencies like famine, fines, diseases and school fees payment to most farmers. It was hypothesized that, the more livestock kept by farmers, the household has the ability to sell and increase household income for meeting various expenses.

TTHME = Total household members (existing number of people in the household). More members in the household imply the availability of labour in that household. Labour is an important factor of production, if it is planned properly it enables effective utilization of other factors of production. The hypothesis was that the more the numbers of members available in the household, the bigger the income of the household earned because of bigger labour force, which will be involved effectively in the production of more crops, livestock keeping and AF practice. On other hand if this labour is not utilized properly, the income obtained will not be adequate to meet the household basic needs and thus less livelihood improvement will be achieved.

AGE = Age of the respondents. Age is an important factor as it is involved with experience and wisdom in decisions of integrating of various factors of production. It is hypothesized that, as the age of an individual increases, households income increases as a result of experiences obtained on production techniques. However to a certain extent, income of the

household is expected to decrease because of the inability of the farmer to participate due to older age and related problems.

The hypothesis that was tested included the null hypothesis (H_o) against the alternative hypothesis (H_i).

Null hypothesis (H_o)

$$H_0: \quad ATTHHI = f\ (AMTRE, CRHAR, LIVK, TTHME, AGE)$$
$$\qquad\qquad\quad + \qquad + \qquad + \qquad +/- \qquad +/-$$

Meaning that there is no correlation between dependent and independent variables in the regression model i.e. ($\beta_{1.....5} = 0$)

Against the alternative hypothesis H_i

$$H_1: \quad \neq f\ (AMTRE, CRHAR, LIVK, TTHME, AGE)$$
$$\qquad\quad + \qquad + \qquad + \qquad +/- \qquad +/-$$

Meaning that there is a positive or negative relationship between dependent and independent variables in the regression model i.e, ($\beta_{1.....5} \neq 0$)

The indicated signs (+, - and +/-) below each predictor represent the hypothesized influence of each independent to dependent variable when it increases by one unit. For instance, the application of AF products in the regression model as the predictor or independent variable will influence the increase or decrease of the ATHHI depending on the sign of coefficient of the relevant predictor.

By using a two tailed t-test at 95% level of significant, the H_o was rejected only where $p<0.05$.

(b) Multicollinearity test

According to Larget (2007), multicollinearity occurs when two or more predictors in the model are correlated and provide redundant information about the response. When multicollinearity is present, important variables can appear to be non-significant and standard errors can be large. Multicollinearity typically occurs when two or more variables measure essentially the same thing (possibly in different ways). It is best to remove excess variables to eliminate multicollinearity. Estimated coefficients can change substantially when parameters are added or dropped.

Before developing and testing the regression model, examinations of correlations was conducted. Firstly, the multicolinearity test between any two variables was achieved by running correlation matrix using a Pearson's correlation. In this test, extremely high values (above 0.9 in absolute value) suggest that some pairs of variables are not providing independent information and to that extent the variable should be removed from the model. Secondly, multicolinearity was identified also by using Tolerance measure (Chan, 2004). In this test, the tolerance value lies between zero to one, the value close to zero indicates that a variable is almost in linear combination of the other independent variables and that value if included in the model will have no significant impact and its standard error will tend to be large. Therefore, the acceptable tolerance value for the independent variable that is acceptable in the linear regression model should be above 0.4. According to this study, tolerance measure test was adopted because it was easier to handle.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics

Socio-economic characteristics of farmers studied included age, gender, marital status, years' of residence, education level, household and farm size. These characteristics were chosen in order to get an overview of the composition and status of the respondents for the purpose of drawing implication in relation to AF practices in the study area.

4.1.1 Age, gender and marital status

Table 1 summarizes the socio-economic information on age, gender and marital status of the respondents. Among the 127 farmers interviewed, the middle age class dominated, it ranged from 18 – 39 and 40 – 59 years representing 48.0% and 37.8% of the sampled population respectively. Young people below 18 years composed only (8.7%) and old people above 60 years composed (7.9%). The middle age class dominance was common phenomenon for Shinyanga and Tabora region (TAFORI, 2004b). This indicates that, labour resource in most household families in semi-arid areas is sufficient for farm activities including AF practices.

The survey also found that 76.4% and 23.6% of household heads were males and females respectively. This shows that most household were headed by men than women. Since household heads are decision makers in the households, decisions on how much and where to sell and spend incomes obtained from AF were more influenced by men than females. This is due largely to the fact that in most partrilinear African societies, a woman has no decision and right over land (Salami *et al.*, 2002). The encountered women household

heads during the survey were either widows or separated or single. Since women have been playing important role in agriculture, for example in Uganda and slopes of Mount Kilimanajaro and Manyoni in Tanzania (Salami *et al*., 2002, Katega, 2002), it is suggested that for livelihood improvement through agroforestry practice in the district, a balance of involvement between genders is advised for wise use of incomes and implementation of agroforestry practices.

Table 1: Age, gender and marital status of respondents (n=127)

Characteristics	Variable	Number	Percent
Age	Below 18 years	10	7.9
	18 - 39 years	61	48.0
	40 - 59 years	48	37.8
	Above 60 years	8	6.3
Gender	Male	97	76.4
	Female	30	23.6
Marital status	Single	7	5.5
	Married	90	70.9
	Divorced	6	4.7
	Widowed	13	10.2
	Separated	11	8.7

4.1.2 Year of residence and educational level

The year of residence and educational status of the respondents are presented in Table 2, indicating that most of the household have resided in the area for a period of 20 – 39 years and 40 – 59 years representing 41.7% of the sampled population in each category. The longer the period for an individual stay in the given area, the substantial indigenous knowledge accumulated necessary for coping with the environment crisis such as adopting various innovations in order to improve incomes for meeting daily household basic needs. According to Makawia (2003), age and experiences of an individual play an important role in application of indigenous knowledge and innovations. The innovations which could be either with negative or positive impact like in situ conservation, tree planting or encroachment of the restricted forests.

Table 2: Year of residence and educational status of respondents (n=127)

Characteristics	Variable	Number	Percent
Year of residence	Below 20 years	11	8.7
	20 - 39 years	53	41.7
	40 - 59 years	53	41.7
	Above 60 years	10	7.9
Educational level	Informal education	22	17.3
	Adult education	27	21.3
	Primary school	71	55.9
	Secondary school	7	5.5

The survey also revealed that about 55.9% of the population have at least acquired primary education showing that farmers were capable of accessing useful skills through reading, witnessing and listening; skills if adopted for example AF practices could lead to the improvement of well-being. According to Maro (1995), primary school education system foster human creativity and have the relationship with farmer's readiness to integrate innovations for livelihood improvement.

4.1.3 Household and farm sizes

The household and farm sizes results are shown in Table 3. The mean households' size was 8 persons, with a range of 5 to 9 persons (55.9%). According to National Population and Housing census of 2002 (URT, 2003; URT, 2005a), the mean household size in Misungwi District was reported to be 6.7 persons. The size obtained in this study is within the range reported. The studied household size implies the availability of labour force in the population for food production, livestock keeping and involvement in AF practices.

The mean land size for these households was 4.2 ha (10.3 acres), the lowest being 0.5 acre and maximum 28 ha (70 acres). The majority of households had the land size ranging from 2 – 7.6 ha (55.9%), (Table 3). However, according to Otsyina *et al.* (1997), the average

land holding in semi-arid areas of Shinyanga was 14.4 ha, higher than found in the study area. This indicates that, in semi-arid areas, land for AF practices is not a big problem; the problem could be the aridity condition for AF success in contrast with high potential areas. For example, land holdings in Marangu and Mamba, in Kilimanjaro ranged between 0.25 – 1.0 ha (Epaphra 2001). Similar results were reported also by Kessy (1992) with land holding of 0.58 ha in Legho Mulo, in Kilimanjaro region. These land shortages have made farmers to adopt homegarden practice which have been providing better results due to favourable climatic condition.

Table 3: Distribution of the household size, land size and land acquisition (n=127)

Characteristics	Variable	Responses	Percent
Household size	Below 5 people	23	18.1
	5 - 9 people	71	55.9
	10 - 14 people	21	16.5
	Above 15 people	12	9.4
Land size	Less than 5 acres	36	28.3
	5 - 19 acres	74	58.3
	20 - 34 acres	13	10.2
	35 - 49 acres	3	2.4
	More than 50 acres	1	.8
Land acquisition[1]	Purchased	93	73.8
	Allocated by village GVT	31	24.6
	Inherited	149	96.0
	Cleared	5	4.0
	Allocated by parents (alive)	28	22.2
	Hired	7	2.5

[1] Land acquisition is from multiple responses.

Most of the land was used for agriculture (95.1%) including tree planting and a small percentage (4.9%) for grazing, implying agriculture was a priority to farmers than livestock keeping. Mode of land acquisition was mostly through inheritance (96.0%), other modes included; purchasing (73.8%), allocation by village government (24.6%), allocation by parents who are still alive (22.2%) and small amount was through clearing (4.0%). Land

allocation by parents who are still alive will eventually turn into inheritance in future making every respondent to acquire part of his or her farm through inheritance. The allocation of village land to farmers in the study area was done as an incentive towards tree planting and AF practices in project villages (Iteja, Igokelo and Misungwi). This kind of land acquisition didn't motivate more farmers to extend the practice to their own lands acquired through other means. For non-AF participants (Mabuki, Lubuga and Mapilinga), there has been no or little involvement in AF practices because of little or no project sensitization.

4.2 Poverty Levels of Communities in the Study Area

Through involvement of key informants using community poverty analysis criteria, three levels of well-being were identified in the study area, these included rich, medium and poor as indicated in Table 4. Among others, rich households had lands area more than 20 acres (8 ha), more than 30 cattle, capable of consuming three meals per day and meeting hospital charges. The medium level households had land area from 2 – 4 ha, cattle from 10 to 30 and also capable of meeting three meals per day. Poor households had land less than 2 ha; houses were thatched with grasses, could achieve one to two meals per day and couldn't meet private health services and education costs. To a large extent, these are features used to identify poor and non poor individuals' households and societies or communities (Tanzania National Website, 2007). An individual household or community found to possess some or all of these features in various levels can be identified as rich or poor.

Table 4: Wealth ranking criteria for households in the study area

Poverty level	Wealth ranking criteria
Rich	• Capable of paying school fees up to secondary school and higher learning institutions both in private and Government schools • Has land area more than 20 acres • Has cattle more than 30 • It is assured to consumes three meals per day • Capable of meeting hospital charges • Has Bicycles more than 3 • Has good house with corrugated iron sheet
Medium	• It is capable of meeting primary school fees and secondary school with difficulty • Has land area between 5 -10 acres • It is capable also of meeting three meals per day • Has 10 -30 cattle • Capable of meeting hospital charges • The house can be constructed with burn or mud bricks and roofed with corrugated iron sheet or grasses • It has the bicycles 1 to 2
Poor	• Cannot meet education costs • Can achieve one to two meals per day • Has the land area between 1 and 5 acres • Has no cattle or has less than 10 cattle • The house is roofed with grasses • Has no transport facilities • Cannot meet treatment costs

The rich households for both AF and non-AF participants in the study area were 18.5% and 12.6% respectively (Table 5). Poor AF households were few (39.2%) compared to non-AF households (51.9%). This indicates that AF participants were bit richer than non-AF participants. However, their average proportion was still higher than 35.7% reported by URT (2005c) in rural areas, indicating that there is still abject poverty particularly of semi-arid areas. The existing difference in well-being levels could have been contributed by difference in attitudes of farmers in participating in various income generating activities, including AF. This implies that AF farmers were more involved in income generating activities than non-AF participants.

In the district, it shows that the existing AF farmers were mostly innovators of any development interventions delivered and were keen in testing them for increasing their

incomes for livelihood improvement and poverty income reduction. However, it is a common phenomenon that farmers like any other kind of entrepreneur; do not adopt innovations simultaneously as they appear on the market. Diffusion typically takes a number of years, seldom reaches a level of 100% of the potential adopters population (Diederen *et al.*, 2003). Since the majority of farmers in the area were accessible to all factors of production (land and labour), it is expected that with more skills on how to best utilize these factors, will eventually be involved in income generating activities, including AF practices.

Table 5: Well-being status of household in the study area

Category	Well-being %			Total
	Rich	Medium	Poor	
AF participants (woodlots) (n=47)	18.5	42.3	39.2	100.0
Non AF participants (n=80)	12.6	35.5	51.9	100.0

4.3 Agroforestry Systems and Technologies Practised

The survey revealed two types of AF systems existing in the area namely agrosilvicultural and silvopastoral systems. The agrosilvicultural system included three AF technologies (Table 6), these were woodlots (37.7%), boundary plantings (4.0%) and live fences (20.8%) and silvopastoral system included Ngitiri (15.2%) practice. Results indicate that at least every AF participants had more than one AF technologies. Surprisingly even those who were considered not AF participants, they practiced other AF technologies other than woodlot making AF participant to be 76 and 51 non-AF participants.

Table 6: Agroforestry technologies adopted in the study area (n=127)

AF participation[2]	Responses	Percent
Woodlots	47	37.7
Boundary plantings	5	4.0
Ngitiri	19	15.2
Live fence	26	20.8
Not involved	51	40.8

[2]The Data is from multiple responses

Some of AF technologies found in the study area (Table 6) were practiced also in semi arid and Miombo areas of Shinyanga and Tabora respectively (Otsyina, *et al.,* 1997; Ramadhani *et al.,* 2002) than in high potential areas. For instance, according to Epaphra (2001), Shalli (2003) and Mtuya (2006), more than 40% of household in high potential areas of Kilimanjaro Region, Kibaha District, in Costal region and Mvomero District in Morogoro, practice homegarden technology. However, that reported by Mbwambo, and Chingonikaya (2005) in semi-arid areas of Magu and Mara was not as diversified and stratified as those reported in high potential areas. Differences in AF technologies practiced and their level of performances in these areas are more influenced by climatic condition, level of soil fertility, land holdings existing and level of population. Tree species encountered in AF systems in the district are indicated in Table 7.

Table 7: Tree species established in agroforestry systems in the district

Local name	Scientific Name	Common name	Uses/function
Mkaratusi	*Eucalyptus* spp	Eucalyptus	Poles, fuelwood, timber, cash
Mlusina/Mpopote	*Leucana leucocephala*	Leucaena	Fuelwood, hoe handles/yokes, cash
Mializia	*Albizia lebbeck*	Albizia	Fuelwood, timber, poles
Mjohoro/Mchongoma	*Senna siamea*		Fuelwood, poles
Mboyo	*Melia azedirach*,		Timber, fuelwood, hoe handles/yoke
Mwarobaini	*Azadirachta indica*	Neem	Medicine, cash from seeds, poles
Mihale	*Acacia tortilis*		Fuelwood
Minyaa	*Euphorbia tillucalii*	Euphorbia	Fencing, wind break
Mwembe	*Mangifera indica*	Mango	Fruits, cash
Mstafeli	*Annona muricata*	Soursop	Fruits, cash
Mchungwa	*Citrus sinensis*	Orange	Fruits, cash
Mpera	*Psidium guajava*	Guava	Fruits, cash
Mpapai	*Carica papaya*	Pawpaw	Fruits, cash

In semi-arid areas with the plenty of land; woodlots, Ngitili practice and free range grazing might be preferred than homegarden and zero grazing. This was the same case for semi-arid areas of Nigeria where farmers practiced more on woodlots (68%) and none in homegarden (Adeola *et al.*, 2001). The homegarden practices have been mostly occurring where farmers want to maximize return from a small piece of land as a result of increased population like in mountain slopes of Kilimanjaro, Bukoba and Mbeya in Tanzania (Msikula, 2003). However, farmers in the study area preferred woodlots than other technologies like boundary planting, Ngitili and live fence because of low management cost and higher return achieved, the same reported by Otsyina *et al.* (1996). These have influenced arrangements of AF components and benefits obtained as well. The AF components occurring in semi-arid areas are arranged spatially and temporally while those occurring in high potential areas are both arranged on the same land management unit (Young, 1989; Nair, 1990). This means that in semi arid areas related AF products for instance wood products could occur at a time while in homegarden, diversified and unrelated products occur at the same time like crops and livestock because of the management used.

The existing AF systems in the study area indicate the potential for AF adoption. When participating farmers were asked on their future planning, the majority (83.0%) indicated intention of expanding their woodlots, though they requested more skills (55.5%) and assistance of seedlings raising materials (16.9%) or the government to re-initiate tree planting project in the area (16.9%). Therefore, the existing adoption potential in the district will be improved if the right technologies and skills for AF systems are provided to both for AF and non-AF participants. From the array of technologies and practices, farmers will have an opportunity of choosing technologies basing on the interest and objectives.

4.3.1 Agroforestry technologies and practice existing in the study area

4.3.1.1 Woodlots technology

Woodlots in the study area were about 14 years old and were under fallow, implying that there were no any agriculture activities going on (Figure 3). Most of the planted trees in woodlots technology were exotic species like *Eucalyptus* species (93.6%), *Leucaena leucocephala* (63.8%), *Melia azedarach* (53.2%), *Albizia lebbeck* (48.9%) and fruit species (10.6%), (Table 8). Basically, these species were introduced in order to meet critical fuelwood demands for domestic uses and maintenance of conditions allowing for sustained agriculture and livestock production (Mnzava, 1980; Kaale, 1984). Other species like *S. siamea* and *L. leucocephala* were among the species planted in many places in the country for fuelwood and poles production. According to Nshubemuki (1998), trees for afforestation and plantations were introduced in the country during the colonial era and there have been screening, provenance trial and scaling up of these species for wider adoption in the country.

Figure 3: Managed coppices of *Eucalyptus* species in project villages.

Planted trees species in the area were mainly exotic which were provided free by the project. All participating farmers in the study area depended on seedlings from the project (100%), yet 14.9% raised their own seedling to supplement on the project seedlings. This shows that there is a possibility of farmers to sustain themselves on seedlings availability in the long run, provided they are empowered with necessary skills.

Table 8: Tree species planted in woodlots (n=47)

Tree species[3]	Responses	Percent
Eucalyptus species	44	93.6
Leucana leucocephala	30	63.8
Albizia lebbeck	23	48.9
Senna siamea	17	36.2
Melia azedirach	25	53.2
Azadirachta indica	14	29.8
Fruits	5	10.6

[3]The Data is from multiple responses

Differences in proportions of planted species in the woodlots were caused by farmers' preferences and expected outputs. Farmers planted more *Eucalyptus* species than other species because the species is familiar to them and has potential for income generation through sales of poles and firewood. *Eucalyptus* is well known for its fast growth and ability to coppice after repeated harvestings. According to Bukenya (2003), two poles per stump of *Eucalyptus* species doubled the yield for subsequent rotation of trees and it was considered as the most paying marketable species in Mukono District in Uganda. The same case was reported in Miombo area of Tabora, where *Acacia crassicarpa* species was preferred most by farmers due to its fast growth (Ramadhani *et al.,* 2002). This indicates that farmers need fast growing tree species for quick returns from their lands. Efforts have to be made to deliver an alternative and diverse species with ability to grow fast to meet a range of products like poles, fuelwood, timber, medicines and fodder. According Franzel and Scherr (2002), diversity of species are found to diversify income and thus reduce risk of market failure. However, farmers who were not under the project (20.3%) mentioned seedlings availability as a constraint for their adoption and thus requested to be considered for education (35.4%) in terms of seedlings raising techniques and AF management (Table 9).

Table 9: Factors constrained adoption of agroforestry in non-project villages.

Item	Responses	Percent
Lack of education	28	35.4
Lack of land	29	36.7
Threat of birds in the field	1	1.3
Lack of seedlings	16	20.3
Uncontrolled livestock	3	3.8
Fear of trees to be nationalized	3	2.5
Total	**80**	**100.0**

Alongside with the appreciated benefits from woodlots, the study also found that there were emerging threats of species and insects invasion in the district which will reduce

productivity and development of AF unless measures are taken to control them. For example *L. leucocephala* was claimed to invade areas where they were not planted and intended. In other places, this species has been regarded as a weed because of its profuse growth and its ability to colonize the area easily termed as '*Mpopote*' meaning for everywhere. According to The Global Invasive Species Database lists, *Leucaena leucocephala* is among "one hundred of the World's worst invasive alien species (Queensland Government, 2004). This implies that a mechanism to manage the colonizing effect of Leucaena could be developed and also there should be a thorough selection and evaluation of tree species for future AF practices.

Insects' infestation (21.3%) in woodlots (Table 10) was reported to be the problem in *Eucalyptus* species. The insect which has been diagnosed as Blue gum chalcid (*Rhicnopeltella eucalypti*) has been infesting leaves and petioles of *Eucalyptus* species. According to Kirubi and Makena (2004), Blue gum chalcid is an insect in the bee-wasp family which causes formation of galls on twigs, foliage and petiole of the host trees. Repeated attacks on growing tips (shoots) lead to a gnarled or twisted appearance (Figure 4). This causes the tree to lack terminal leader shoot, leading to umbrella-shaped canopy instead of conical. Sometime the chalcid may kill the tree by feeding on the leaves, especially during its larval and adult stages. It is native to Australia and it extensively damages the Eucalyptus in many countries including East Africa. In the study area, twisted growing tips with galls on twigs, leaf petiole and foliage were observed in some *Eucalyptus* species. Although some control measures have been suggested to alleviate the problem like quarantine and cultural methods, but none of methods have been applied in the study area. This indicates that, the tree which is potential for household income generation is under threat of vanishing unless control measures are emphasised by relevant institutions like TAFORI and Tanzania Tree Seeds Agency (TTSA).

Figure 4: *Eucalyptus* species shoots infected with Blue Gum Chalcid.

Regardless of the importance of fruit trees to their contribution to the nutritional improvement and income generation to the household, yet they haven't been grown much (10.6%) because of the climatic condition existing in the study area (Table 8). According to Mbwambo (2004), the rainfall in the semi-arid areas is inadequate and unreliable. Unreliability means there can be a prolonged dry season or dry spell between and within the rain season which can affect agricultural activities including AF practice development. However, when farmers were asked on the problem encountered during managing the woodlots, drought was not a major problem (17.3%), the problem was on livestock destruction to young coppices (63.8%) and theft (57.4%), (Table 10). This indicates that drought in semi-arid areas could be a big problem during tree establishment rather than affecting mature trees. Similar findings were reported by Ramadhani *et al.* (2002) in Tabora. Since mature trees are not affected by drought conditions especially those existing in semi-arid areas, trees and shrubs due to their rooting systems, they are expected to

sustain farmers with fuelwood and incomes. During such conditions, farmers can harvest trees (poles and firewood) and sell them to earn income for livelihood improvement (Dwived, 1992; Kamwenda, 2002). This indicates that, farmers practising AF have more alternating sources of income in different periods of the year than farmers practising conventional agriculture.

Table 10: Problem got by farmers during managing the woodlots (n=47)

Problems[4]	Responses	Percent
Drought	8	17.0
Diseases and pests	10	21.3
Theft	27	57.4
Livestock destruction	30	63.8
None	7	14.9

[4]The Data is from multiple responses

4.3.1.2 Ngitili practice

Ngitili practice in the study area has not been much adopted (Table 6), only (15.2%) of households participated. This indicates the effort that was done by the previous projects like FRMP (Ngate, 2001), was not sustained by more farmers. Ngitili farmers mostly obtained fodder (74.1%) and fuelwood (25.9%) which were of poor quality and insufficient. Problems mentioned leading poor Ngitilis were uncontrolled grazing (80.0%), drought (50.0%) and lack of skills for the management (30.0%). This implies that land in the study area is still open access to most of farmers. However, with the present Village Act of 1999, which has decentralised the land to the village authority, it is expected to foster land conservation and respect and thus improve economic development over this land.

Farmers in the study area were aware of the importance of by-laws (43.8%) for supporting Ngitilis development. The traditional by-laws have substantially improved development of

Ngitili in semi-arid areas of Shinyanga, where an individual farmer is punished after has failed to abide to the management plan for the reserve (Kamwenda, 2002; Mlenge, 2004; MNRT and IUCN, 2005). Emphasis of these by-laws in the in Misungwi district, will promote regeneration of grasses for livestock, trees and shrubs. According to MNRT and IUCN, (2005) regeneration of trees in Ngitilis is largely through coppices re-growth and root suckers rather than through seeds. Through Ngitilis, farmers will conserve land as well as will have enough fodder for their livestock, trees for households' use and income generation through sale of products, including fodder.

For instance, the study that was conducted in semi-arid area of Shinyanga found income from Ngitili to surpass the national average consumption per person of Tshs 8 500 at estimated benefits per person of Tshs 14 046.00 (14 US$) per month (MNRT and IUCN, 2005). Hence, Ngitili revivals and improvement is necessary so that it can contribute to households and poverty reduction to the majority rural households in the district. Ngitili improvement refers to introduction of both productive and nutritious fodder trees, herbs and grasses (Otsyina *et al.*, 1995) (Figure 5). The suggested tree species for Ngitili improvement include *Leucaena leucocephala, Grilicidia sepium, Acacia angustissima L. pallida, L. diversifolia, L. collinsii* and L. hybrid; herbaceous legumes are *Clitolia ternatea*, *Lablab purpureus, Macroptilium atropurperium* and grass species are *Cencrus ciliaris, Cloris guyana.*

Figure 5: Ngitili improved with *Grilicidia sepium* and *Cloris guyana* in farmer's field in semi-arid areas of Shinyanga, Tanzania.

4.3.1.3 Live fence technology

Indigenous live fence is the common technology practiced in semi-arid areas. In the study area (Table 6), 20.8% of households were found to practice this technology because of its ability to establish easily, withstand drought and form dense barrier. It has been established with *Eurphorbia tillucalii* species to enclose households and livestock (50.0%), for fuelwood production (10.5%), and windbreak (39.9%). Although the purpose of live fences may vary from one place to another, in other places it used to keep domestic and wild animals out. It may also be used to demarcate areas where general access is discouraged (Rocheleau *et al.*, 1988). This finding concur with the study conducted by Guggenberger *et al.* (1989) who found that, live fence establishment normally is done by households that have made permanent settlement in villages; they plant hedges around their compounds for privacy and to exclude free grazing cattle.

The study also found that, cooking with *E. tillucalii* was diminishing probably because of the availability of alternative sources of firewood from woodlots and boundary plantings and the effect of smoke which caused red eye and witchcraft suspect to old women. Thus, in order to increase the range of products from live fences and avoid some side effect like poisonous sap to children, occurrence of red eye to old women, range of species have to be used. Depending with the site conditions, live fence species which can save the same purposes in the area include *Ziziphus abbyssinica*, *Z. mauritiana*, *Z. mucronata*, *Dovyalis caffra, Senna atomalia, Erythrina abbyissinica* and fruit trees like *Psidium guajava* (Rocheleau *et al.*, 1988; Otsyina *et al.*, 1997). These trees, produce strong and effective fences, they coppice profusely with many strong and fast growing branches which could prevent effect of animals to protected assets.

4.4 Agroforestry Benefits in the Study Area

4.4.1 Identified products and benefits

Agroforestry products from the study area mainly originated from the tree component in woodlots and boundary plantings. From multipurpose trees in woodlots, farmers acquired poles, firewood, hoe handles/yokes, timber and medicines as indicated in Table 11. According to Wood and Burley (1991), multipurpose trees are the ones purposefully grown or conserved to provide more than one significant contribution to production or service function to the community.

Products or benefits acquired from the woodlots in semi-arid areas varied in proportions depending on the potentiality of tree species (Figure 6). Species that were used in high proportions included *M. azedarch* for timber (92.0%), *A. lebbeck* for household firewood (86.4%), *Eucalyptus* species produced poles for selling (80.0%), *L. leucocephala* was used

for household firewood (79.3%). Other species were used in small proportions such as *S. siamea* for household fuelwood (10.2%), *A. indica* for selling seeds (3.1%) and medicines (3.9%). *M. azedarch* species, which was established by 53.2% (section 4.3.1.1.), was observed to be an important species for timber production.

The timber small-scale production in recent years is increasingly appreciated as an important source for many countries' for wood supplies, for instance in Kenya, Bangladesh and India (Garrity, 2004). In the case of poles for selling in the study area, it was according to the earlier suggestion provided by Guggenberger *et al.* (1989) that tree poles produced near cities could gain more markets because of the deficit and the increasing demand in towns. According to the study conducted by Ngate (2001) growing trees for poles production was the priority to most farmers in the Lake Victoria Zone.

Results also indicate that all tree species in the study area were useful for fuelwood; for instance *A. lebbeck* and *L. leucocephala* were used most by 86.4% and 79.3% of the respondents respectively, while *S. siamea* and *A. indica* were least used by 10.2% and 1.6% of the respondents respectively. Fuelwood yields and requirements per individual are elaborated more by Otsyina *et al.* (1996) and Nshubemuki (1998) for *Acacia polyacantha* and *Eucalyptus* species. From a woodlot of 5 to 6 years, it produced 10 to 15 tonnes of wood per hectare which was enough to sustain a family of 6 to 8 persons for 2 years at a daily use of 1 kg per person. This can be the same case for all fast growing species with approximately the same wood density. The wood density dictates the calorific value that has the implication on the heat intensity and burning efficiency per unit of wood. This shows that a household having one hectare of trees will have the ability to sustain in fuelwood requirements and has excess to sell for income generation.

The case was different for non-agroforestry farmers; they had to walk longer distance searching for fuelwood or had to purchase from farmers with woodlots. It was estimated that a farmer searching fuelwood walked up to 3 km, approximate the same (3.5 km) of that reported by Ngate (2001) in the Lake Victoria Zone; while those who purchased paid Tshs 5000.00 (4 US$) per oxcart and normally household size of 7 people in the study area spent in average of 3 oxcart per year. According to Bakengesa and Ostyina (2000) it is equivalent to 9 m^3 of solid wood (1.3 m^3 per capita per year) and a bit higher than that reported in Meatu district in Shinyanga region, where 6 m^3 for 8 people per year (0.75 m^3 per capita per year) were used. Therefore, findings from Misungwi district is lower than that reported by Zilihona *et al.* (2005) in Kwimba and that of Nkonoki (1999) in Lushoto of 1.8 m^3 and 2.3 m^3 per capita per year respectively. However, in Tanzania depending with difference in calorific value, fuelwood for household use can range from 1.3 to 2.3 m^3 of solid wood per capita per year (Inshengoma, 1994 cited by Zilihona *et al.*, 2005). The study reveals that, AF farmers were more beneficial than non-AF farmers, because they acquired additional money through selling of poles and fuelwood and also saved money and time that could be used for buying or searching for fuelwood. The additional money obtained by AF farmers in the study area was spent for various uses in the households (97.7%), like purchasing food stuff, livestock, clothes and house's renovation.

Figure 6: Collected poles from farmers' field for selling in nearby towns.

Other benefits from woodlots mentioned by farmers included harvesting of thatch grasses (32.7%), environmental protection (28.8%) and beekeeping (1.9%). This indicates that in the area there were other additional benefits associated with AF practice, which their potential has not been much exploited, for instance fodder utilization and beekeeping. Since farmers restricted themselves from grazing in woodlots, they could use cut and carry methods of fodder (grasses and Leucaena leaves) to supplement animals after normal grazing hours. The practice could improve milk production, animal health and manure produced, all of which could have positive impact to household incomes and finally to poverty income reduction.

Table 11: Various uses/benefits of multipurpose trees in the study area (n=47).

Tree species	Uses/benefits (%)									Total (%)
	PSELL	PHH	FSELL	FHH	TIMB	HND/Y	SEEDS	MED	FERT	
Eucalyptus spp	80.0	13.3	2.2	77.8	15.6	4.4	-	-	-	193.0
A. lebbeck	-	9.1	9.1	86.4	18.2	4.5	9.1	-	-	136.4
L. leucocephala	6.9	27.6	3.4	79.3	3.4	48.3	-	-	17.2	186.2
M. azedirarch	4.0	-	4.0	40.0	92.0	4.0	4.0	-	-	152.0
S. siamea	-	0.8	1.6	10.2	-	-	-	-	-	100
A. indica	-	1.6	-	1.6	-	-	3.1	3.9	-	100

Key: PSELL: Poles for selling, PHH: Poles for household use, FSELL: Fuelwood for selling, FHH: Fuelwood for household use, TIMB: Timber, HND/YK: Hoe handles/yokes, SEEDS: Seeds for selling, MED: Used for medicine FERT: Fertility improvement

Beekeeping sector in the district requires more attention because of its potential to livelihood improvement. According to Mwakatobe and Mlingwa (2005), beekeeping sector is an important income generating activity with high potential for improving incomes and nutritional status in households. At domestic market, 1 kg of honey is sold between Tshs 762 (0.6 US$) and 3175 (2.5 US$), with a bit higher price in cities and towns like Dar-es Salaam, Mwanza, Arusha, and Moshi. It also plays a major role in improving biodiversity and increasing crop production through pollination. This was the same case emphasised by Ngate, (2001) in Mwanza region. With proper planning using the improved beehives in woodlots, the practice could contribute to the income of the household and improvement of livelihood in the district. Therefore, results from this study reveal that agroforestry products in semi arid areas have the role to play in improving household needs, incomes and poverty reduction and acceleration of achievement of the MDGs.

4.5 The Contribution of Agroforestry Products to the Household Income

4.5.1 Cash income from agroforestry and non agroforestry participants

Three indicators were used to identify incomes of farmers; these included agricultural crops, livestock and trees. Farmers were interviewed on the amount of income they earned through sales of these items. Comparable average of incomes and percentages of contribution for each product both for AF and non-AF farmers are presented in Table 12.

Results from survey indicate that AF participants in semi-arid areas of Misungwi district annually had extra income than non-AF participants at average of Tshs 954 611 (760 US$), the extra income that was higher than that reported by Bonifasi (2004) of Tshs 117 384.00 (93.2 US$) in high potential areas of Lushoto, in Tanga region. However, the income obtained by Mbwambo and Chingonikaya (2005) in semi-arid areas of Magu district in Mwanza region and Musoma district in Mara region of wood products and crops is

comparable with the income of wood products alone from semi-arid areas of Misungwi district. Difference in incomes between farmers from semi-arid and high potential areas may be were attributed by factors like type of AF systems and technologies adopted, number and type of trees species established and sold and land holdings. Furthermore, the extra incomes obtained by AF participants probably were contributed by levels and readiness of these farmers in testing different interventions when delivered to them, like adoption of improved seed crops, planting spacing, application of farm yard manure or fertilizers, proper management of indigenous livestock, keeping of dairy cattle and tree planting as compared to non-AF participants.

Table 12: Annual incomes for agroforestry and non agroforestry participants

Income	Minimum (Tshs)	Maximum (Tshs)	Mean (Tshs)	Contribution (%)	Std. Deviation
AF participants incomes					
Woodlot (Wood products)	1 000.00	500 000.00	82 078.95	5.5	106 209.03
Crops	25 000.00	4 500 000.00	823 823.53	55.5	1 061 274.31
Livestock	495.00	10 000 000.00	578 960.54	49.0	1 866 760.36
Total for AF participants	**26 495.00**	**15 000 000.00**	**1 484 863.01**		**3 034 243.71**
Non AF participants incomes					
Crops	21 000.00	1 750 000.00	315 616.18	59.5	355 455.02
Livestock	6000.00	1 000 000.00	214 636.36	40.5	187 428.14
Total for Non-AF participants	**27 000.00**	**2 750 000.00**	**530 252.54**		**542 883.16**

However, the contribution of each item to total annual cash household income was different as indicated by their percentages in Table 12. The wood products from AF systems, in average contributed only to 5.5% of AF household incomes while agriculture contributed about 51% for both AF and non-AF household incomes. Similar observations were made by Epaphra (2001) whereby incomes obtained from crops and livestock in Marangu and Mamba in Kilimanjaro region were higher when compared to woods products. According to URT, (2005c), agriculture has been the leading sector in the country with the largest share of GDP with approximately 50 per cent since 1990; yet, its

impacts to poverty reduction in rural areas has been low. This is because; most of farmers have been depending on food crops for income generation. The overselling of food has been leading to food shortages in certain periods in a year, increasing poverty among rural households as the majority lack alternatives to supplement them. This shows that other environmental interventions like AF practices should be promoted to supplement household incomes and achievement of MDGs.

However, tree component together with its importance in AF systems, still not given greater weight by farmers as compared to agricultural crops. Contribution of wood products (5.5%) in the study area to annual total household income was lower than that provided by Makawia (2003) and Msikula (2003) of 16% and 9.1% respectively and that of USAID (2004) of 10% to 15% of GDP of forest sector at national level. However, these contributions at household level and national level are still underestimated because of some data haven't been recorded and quantified. For example information like time saved searching for wood products, ecological values, land security and self esteem at household level. Trees as an investment like agricultural and livestock keeping can provide farmers with a range of marketable products such as lumber, building materials, fuelwood, animal fodder, fruits, medicines resins, tannins, gums, honey, beeswax, dyes, and spices, all of which can earn extra income (ICRAF, 2000).

4.5.2 Development of linear regression model

It was necessary also to determine the significance or the extent of the contribution of agroforestry products (tree component) in relation to other products (agriculture and livestock incomes) to total annual household income. Therefore a linear regression model was developed using five predictors explained in section 3.2.2.4

Prior to the development of regression model, the multicollinearity test was conducted in order to remove predictors that were closely related or measured the same thing. It intended to retain variables that had significance to the total household income.

4.5.2.1 Multicollinearity test

Multicollinearity test was done using the Tolerance Measure test as indicated in Table 13. According to the Collinearity test, Total land size per household was found to have low tolerance value of 0.345. According to Chan (2004), the acceptable tolerance value that can be included in the linear regression model should be above 0.4. Therefore, removal of total land size per household variable (predictor) produced final regression statistics as indicated in Table 14. Coefficients from this statistics were used to develop regression equation.

4.5.2.2 The linear regression equation

The linear regression was developed as follows:

ATTHHI = 296848.215 - 2440.665 AGE - 8402.623 TTHME + 28.287 AMTRE +

7566.642 CRHAR + 7066.290 LIVK

R^2 = 84.4%

Table 13: Regression statistics and collinearity test

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta (β)	t	Sig.	Tolerance	VIF
1	(CONSTANT)	329695.847	180709.400		1.824	.071ns		
	AGE	-4178.402	3586.596	-0.046	-1.165	.246ns	0.810	1.234
	TTHME	-13858.944	13033.391	-0.048	-1.063	.290ns	0.626	1.598
	THHLS	14235.949	7798.574	0.111	1.825	.070ns	0.345	2.902
	AMTRE	11.708	24.443	0.019	0.479	.633ns	0.826	1.211
	CRHAR	7023.869	542.970	0.745	12.936	.000***	0.384	2.606
	LIVK	6657.046	1844.015	0.177	3.610	.000***	0.529	1.892

Dependent Variable: Total household income; ns = not significant at p<0.05; *** = significant at p<0.01

Table 14: Regression statistics after collinearity test

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta (β)	t	Sig.
1	(CONSTANT)	296848.215	181550.250		1.635	.105ns
	AGE	-2440.665	3491.399	-0.027	-0.699	.486ns
	TTHME	-8402.623	12808.705	-0.029	-0.656	.513ns
	AMTRE	28.287	22.912	0.045	1.235	.219ns
	CRHAR	7566.642	458.715	0.803	16.495	.000***
	LIVK	7066.290	1848.038	0.188	3.824	.000***

Dependent Variable: Total household income; ns = not significant at p<0.05; *** = significant at p<0.01

Significance tests

From the regression analysis of variance, t-test was statistically significant, implying that the model was statistically significant at $p<0.01$. It was significant because none of the regression coefficients was equal to zero. Therefore, the null hypothesis H_o: ATTHHI = f (AMTRE, CRHAR, LIVK, TTHME, AGE) was rejected against the alternative hypothesis H_1: ATTHHI ≠ f (AMTRE, CRHAR, LIVK, TTHME, AGE), indicating that total household incomes in the study area were largely influenced by these independent variables. This was explained also by R-squared of 84.4% of the studied independent variables to contribute to total household income. However each independent variable had a different magnitude toward total household income as explained by each coefficient in the regression model. Coefficients for each of the variable indicates the amount of change one could expect in total household income given a one-unit change in the value of independent variable, given that all other variables in the model were held constant.

From the regression model, CRHAR and LIVK were statistically significant at $p<0.01$ and positive implying that agriculture crops and livestock keeping in the study area were still the mainstay of the majority of farmers. The (AMTRE) was not significant but positive, indicating positive influence to the total household income. It implied the increase of AMTRE at one unit will influence total household income increase with the magnitude explained by its coefficients when other factors held constant. Agroforestry practice (tree component) was still given small weight as it is explained in 4.4.2. On other hand AGE and TTHME variables influenced the total household income negatively. This implies that increasing these variables at one unit will decrease total house hold income as indicated by their respective magnitudes. This is because at older age, an individual is not economically active, the only depended in the household to produce are young household members, who

are some time committed with their private businesses. This result concurs with that of Msikula (2003) on age in Eastern Usambara Mountains.

Likewise as the household members (TTHME) increase, for example if they are not committed and probably are headed by a widow or the household head who is sometime older, the production and income will tend to go down because the household will not produce enough to meet individual basic needs like foods, clothes, education, health services and improved houses. This concurs with finding by Kabubo-Mariara (2003), that larger households in rural areas of Kenya were likely to be poorer than smaller households. This situation, together with other factors, may have accelerated poverty in rural areas as households live in extended family without bearing much on the individual participation in household productions. Thus, it is assumed that the more the household is engaged in income generating activities, the higher the income obtained by the household, the better it is placed in improving the well-being and reducing poverty due to ability in meeting basic household needs.

4.5.3 Constraints to incomes from agroforestry systems in the study area

Income satisfaction depends on whether it meets households' daily basic needs. The very basic household needs are important for maintaining minimum standards of living, this include foods, clothing and shelter. Agroforestry participants who were satisfied with incomes from tree products and met their very basic households' needs were 17% and those who did not were 83%. This proportion concurs with the proportion of rich and poor households respectively in section 4.2. This imply that rich households may be had more trees because they had more land and had the ability to find attractive markets for their products than poor households.

Farmers who were not satisfied with income from agroforestry products were mostly poor households and they mentioned various factors as constraints to more income, the major constraints were few trees established (54.4%) and poor selling price (51.3%) and the minor one was lack of seedlings (5.1%), (Table 5). Few trees established could be mainly contributed by farmers' attitudes and unreliability of rainfall which is common phenomenon in semi-arid areas. Amount of rainfall available in the area to some extent doesn't favour establishment and survivals of trees as compared with high potential areas with plenty of rainfall throughout the year. Rainfall in high potential areas ranges from 1000 to 2000 mm per year (Msikula, 2003), while in semi-arid areas ranges from 200 to 1200 mm per year. Thus, an individual farmer in the study area managed to establish at an average of 853 trees, which occupied approximately 0.8 ha. From this area, an average of 212 poles were sold at the farm get price of Tshs 500.00 (0.3 US$) – 1000.00 (0.8US$), contributing to about 159 000.00 Tshs (126.7 US$) which was equivalent to 5.5% of the annual total household income. This price was reported by farmers to be small if compared to the retail price in Mwanza city which ranged from Tshs 5000.00 (3.9 US$) to 7000.00 (5.5 US$).

It is a common phenomena for an advanced entrepreneur to be well informed on the market, access to transport and skilled in bargaining while subsistence farmers are poor informed, do not access to transport and they are unskilled in bargaining (Leakey *et al.*, 2005). What is important is that the community be empowered by community development agent to work together and use their resources to improve their livelihood and reduce their poverty. Assistance on identification at what price a farmer can sell to maximize returns and poverty income reduction can be established through price-cost analysis.

Table 15: Constraints for more production with agroforestry technologies (n= 47)

Constraints	Responses	Percent
Few trees/smaller area planted trees	22	54.4
Poor selling price	20	51.3
Livestock destruction	3	7.7
Lack of seedlings	2	5.1

The lack of seedlings (4.3%), even if considered to be minor, but has big implication in further development of AF practices in the district. Few farmers who run private nurseries, evolved as the result nursery decentralization that has been promoted in recent years. From the discussions with Division and District Forest Officers, there was no central nursery operating for the district; however there were few NGOs, Institutes and Centres supporting nurseries in few places in the district on tree planting and AF promotion. The NGOs included Pambazuka, Green Hope, Usagara Green Foundation, Farmers' Centre for Environmental Enhancement and Ethical Agriculture (KIMKUMAKA) and Mwanza Rural Housing Programme (MRHP). The Institutes and the Centre were LZARDI, ST. Augustine University of Tanzania (SAUT) and NAFRAC. Some of these NGOs, Institutes and Centres, were involved with seedlings raising and training of farmers, primary schools and District Councils on seedlings raising and management of natural resources. However, seedling raised by some of these NGOs reported to be insufficient if compared with the district requirements. Furthermore, farmers' attitudes towards private or individual nurseries were low because of unavailability of raising materials and skills.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

According to this study, it can be concluded that about 92% of households in Misungwi district that live in rural areas; about 45.5% of households are still in abject poverty because they are involved in subsistence farming (agriculture and livestock keeping) that doesn't earn more incomes due to poor markets, unreliable rainfall and they are not involved more in income generating practices like AF.

Farmers who practise AF have extra income and improved well-being than those who depend on conventional agriculture and livestock keeping alone. They obtain extra income from selling and use of AF products and from various activities because they are ready in testing various innovations like adoption of improved seed crops, crops' planting spacing, application of farm yard manure or fertilizers and proper management of livestock, all of which contributed to total annual households incomes.

In AF systems, there are four types of AF technologies practised namely woodlots, boundary plantings, Ngitili and live fence. The woodlot is the dominant technology providing farmers with AF products for household use and contributing to total annual household incomes.

Agroforestry products obtained are poles, firewood, hoe handles/yokes, timber and medicines which are used in various proportions depending on the potentiality of tree species. Other benefits mentioned from AF include thatch grasses, environmental protection and beekeeping.

Incomes obtained from AF products are not as much as from agricultural crops and livestock keeping because of few trees established, narrow range of alternative tree species, poor management in some AF technologies, poor selling price and presence of drought.

Agroforestry as alternative sustainable land use system has a role to contribute to households' income, achievement of national poverty eradication by 2025 and achievement of the MDGs by 2015.

5.2 Recommendations

Since AF practice does not contribute much to total annual household income of farmers in Misungwi district, concerted efforts is required on scaling up of best and management of AF practices for more household income and poverty income reduction. Therefore, the following recommendations have been put forward for AF scaling up, adoption and management improvement.

5.2.1 Recommendation for AF scaling up, adoption and management improvement

Since farmers are not materially poor and agroforestry concept is still knew to some farmers in the District, therefore:

(a) Scaling up of the best management practices that proved good performance in other areas of the same climatic conditions is required in the district for household income improvement.

(b) More skills are required on how to best utilize the available productive resources like (time, labour and land) for maximum utilization and return from land for more household incomes and achievement of the MDGs by 2015.

(c) In making the AF technologies be more productive, resistant to pests and diseases and meeting droughts condition, an array of both exotic and indigenous species are required. This kind of mixtures of planting reduces drought conditions and pests and diseases that can affect single or related tree species. The range of species with fruit species inclusive can make farmers to benefit more from a range of products.

(d) Emphasis for the revival of the indigenous practice like Ngitili and its improvement is important for increasing arrays of technologies for farmers' option and income poverty reduction.

(e) In the district there are reasonable numbers of projects supporting on environmental conservation. Harmonization of these project activities is important in order to avoid wastage of project resources, time and provision of conflicting information to farmers.

5.2.2 Recommendation for future studies

(a) Since there is a big difference of price of poles between farmers and that of retailers in Mwanza City, it is proposed that price cost analysis be conducted in order find at what price a farmer could sell his or her AF products for improvement of AF contribution to total annual household income and income poverty reduction.

(b) The attack of blue gum chalcid to some *Eucalyptus* species in Misungwi District is becoming a threat. Studying the extent of the attack of these insects in farmers' woodlots and implementation of the control measures is advised in order to rescue these potential species.

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APPENDICES

Appendix 1: Household questionnaires for agroforestry participants

Dear household head/respondent,

Your household has been selected randomly so as to provide data that could be used to quantify and document the contribution of agroforestry products to household income and poverty reduction in your area. All the information you will provide will be for academic purposes and be treated confidentially.

Therefore you're kindly requested to respond trustfully and faithfully to the following questions. I thank you in advance.

Name of the household head/respondent: …….
Date of interview: ……Questionnaire number……..
Village: …….....
Ward: …….
Division: ……....

HOUSEHOLD CHARACTERIZATION

1. Respondent's Sex 1. Male……..
   2. Female……
2. Age……. Years
3. Years of residence in the village …….
4. Marital Status

   1. Single……..
   2. Married……
   3. Divorced……
   4. Widowed…….
   5. Separated……..

6. Education

   1. No formal education……..
   2. Adult education……
   3. Primary education……
   4. Secondary education……..
   5. Post secondary education…….

7. Total number of household members:……..

8. Household composition and economic activities

Sex	Age groups composition		Description of economic activities done by the household members				
	Age group	Number	1	2	3	4	5
Men	< 18 years old						
	18 – 55 years old						
	> 55 years old						
Women	< 18 years old						
	18 – 55 years old						
	> 55 year old						
Total							

Key: 1. Crop production 2. Livestock keeping 3. Casual employment 4. Permanent employment 5. Others (Please give details of each)

9. Land parcels, size and mode of acquisition

Number of parcels	Size	Uses	Mode of acquisition
Total			

Key: (1) Purchased (2) allocated by village government (3) inherited (4) cleared (5) others (specify):

10. Which facilities/assets do you own? (1) Bicycle (2) Radio (3) Plough (4) Oxcart (5) Others (specify): ……
11. Type of the house roofing material (1) Corrugated iron sheet (2) grasses (thatch) (3) Others (specify): ……
12. What is the expenditure/ consumption per month?……Tshs……..Tins/bags
13. What is the main source of labour for your farm activities?
    (1) Family members (2) Hired labour (3) Both 1&2 above (4) Others Specify….

AGROFORESTRY PRACTICES

1. Which agroforestry technologies do you practice?
   (1) Woodlot (2) Boundary plantings (3) Others (Specify):
   ……When did you establish it?……
2. Which type of tree species do you own, reason and their ranking

Rank	Tree species	Quantity	Reason/uses
Total			

3. Where did you get seedlings?
   (1) Given free by the project/government (2) Raised myself (3) As above (1) & (2).
   (4) Purchased (5) others (specify): ……
   ……
4. Which crop did you intercrop
   (1) Maize (2) sorghum (3) none (4) other (specify): …….
   Why: ……
5. What are other uses of your agroforestry farm(s)
   (1) Environmental conservation (2) Grazing/ngitiri (3) Beekeeping (4) other (specify):
   …….
6. How much fuelwood do you use annually? ……oxcart/head load…
7. Which problems do you get in managing your agroforestry farm(s): (1) Drought (2) Unreliable rainfall (3) Pests and diseases (4) Theft (5) Livestock destructions (6) others (specify): …….. ……
8. How do you solve them?

	Problem	Solution
(1)	Drought	
(2)	Unreliable rainfall	
(3)	Pests and diseases	
(4)	Theft	
(5)	Livestock destruction	
(6)	Others ……	

9. What were the problem got in managing Ngitili
   (1) Uncontrolled grazing (3) Drought (4) None
10. What are suggestion for ngitili improvement
    (1) Strengthen or establish by-laws (2) To protect the area against other livestock
    (3) To fence the area (4) none

11. What are the uses of live fences
    (1) To enclosure households and animals (2) Use for fuelwood (3) Wind breaks (4) None
12. Do extensionists visit you? (1) Yes (2) No

13. If yes, whom one(s) (1) Agriculture extension officer (2) Forestry extension officer (3) Other(s) Mention……..
14. If not where do you get extension services…….
15. What was the cost for initiating agroforestry farm……
16. What was the management cost……
17. Do you sell any item from you are agroforestry farm (1) Yes (2) No.
18. If yes, which incomes do you get from your agroforestry farm annually

Item	Sources		Quantity (headloads/oxcarts/amount)	Amount in (Tshs) per year	Uses
	Planted	Ngitili			

19. Where do you sell your products (1) village (2) in town (3) Others (specify): ……
20. Do these levels of production from agroforestry and income satisfy most of your household's basic needs? (1)Yes (2) No
21. If no what are the reasons and your suggestions for improvement

	Reason(s)	Solution

FARMING ACTIVITIES

1. What are the major crops do you grow, rank according to their importance

Rank	Type of crop	Cost of production	Harvests (bags/tins/kgs)	Major uses	Income Tshs/year

2. Where do you sell your products (1) village (2) in town (3) Others (specify): ……

3. How do you use the income earned from farming practices
   (1) Meeting basic needs (foods, shelter, clothes) and health services (2) Hiring labour (3) Purchasing of farm inputs (4) buying livestock (5) others (specify): ……
4. Do these levels of production and income satisfy most of your household's basic needs? (1)Yes (2) No

5. If no what are the reasons and your suggestions for improvement

	Reason(s)	Solution

6. Do you keep livestock (1) Yes (2) No
7. If yes, how many and how do you use them?

	Type of livestock	Amount	Uses	(Amount/income)/year

8. What is the annual cost of production, income and uses

	Type of livestock/product	Initial cost	Cost of production/year

9. Do these levels of production and income satisfy most of your household's basic needs? (1)Yes (2) No

10. If no what are the reasons and your suggestions for improvement

	Reason(s)	Solution

11. How do you use the income earned from livestock keeping
    (1) Meeting basic needs (foods, shelter, clothes) and health services (2) Hiring labour (3) Purchasing of farm inputs (4) buying livestock (5) others (specify):
    ……
12. If you are not keeping livestock, what are reason(s) for not keeping? (1) Lack of capital for buying livestock (2) shortage of grazing area (3) other(s) specify:
    ……

13. What are the problems involved with livestock keeping and how do you solve them?

	Type of livestock	Problem	Solution

14. What is your future planning concerning your involvement in agroforestry practices:
    …….
    ……

15. What is your advice for future improvement of agroforestry practices:
……
……

THANK YOU

Appendix 2: Household questionnaires for non-agroforestry participants**.**

Dear household head/respondent,

Your household has been selected randomly so as to provide data/information that could be used to quantify and document the contribution of agroforestry products to household income and poverty reduction in your area. All the information you will provide will be for academic purposes and be treated confidentially.

Therefore you're kindly requested to respond trustfully and faithfully to the following question. I thank you in advance.

Name of the respondent: ……..
Date of interview: ……Questionnaire number…….
Village: …….....
Ward: ……
Division: ……...

HOUSEHOLD CHARACTERIZATION

1. Respondent's Sex 1. Male……..
   2. Female……
2. Age……. Years
3. Years of residence in the village …….
4. Marital Status

   1. Single……..
   2. Married……
   3. Divorced……
   4. Widowed…….
   5. Separated……..

5. Education
   1. No formal education……..
   2. Adult education……
   3. Primary education……
   4. Secondary education……..
   5. Post secondary education…….

6. Total number of household members:…….

7. Household composition and economic activities

Sex	Age groups composition		Description of economic activities done by the household members				
	Age group	Number	1	2	3	4	5
Men	< 18 years old						
	18 – 55 years old						
	> 55 years old						
Women	< 18 years old						
	18 – 55 years old						
	> 55 year old						
Total							

Key: 1. Crop production 2. Livestock keeping 3. Casual employment4. Permanent employment 5. Others (Please give details of each)

8. Land parcels, size and mode of acquisition

Number of parcels	Size	Uses	Mode of acquisition
Total			

Key: (1) Purchased (2) allocated by village government (3) inherited (4) cleared (5) others (specify):

9. Which facilities/assets do you own? (1) Bicycle (2) Radio (3) Plough (4) Oxcart (5) Others (specify): ……
10. Type of the house roofing material (1) Corrugated iron sheet (2) grasses (thatch) (3) Others (specify): ……
11. What is the expenditure/ consumption per month?……Tshs……..Tins/bags
12. What is the main source of labour for your farm activities?
    (1) Family members (2) Hired labour (3) Both 1&2 above (4) Others Specify….

FARMING ACTIVITIES

1. What are the major crops do you grow, rank according to their importance

Rank	Type of crop	Harvests (bags/tins/kgs)	Major uses	Income Tshs/year

2. Where do you sell your products (1) village (2) in town (3) Others (specify): ……
3. Do these levels of production and income satisfy most of your household's basic needs? (1)Yes (2) No
4. If no what are the reasons and your suggestions for improvement

	Reason(s)	Solution

5. Do you keep livestock (1) Yes (2) No
6. If yes, how many and how do you use them?

	Type of livestock	Amount	Uses	income/year (Tshs)

7. What are costs of production, income and uses per year

	Type of livestock/product	Cost of production/year

8. Do these levels of production and income satisfy most of your household's basic needs? (1)Yes (2) No

9. If no what are the reasons and your suggestions for improvement

	Reason(s)	Solution

10. How do you use the income earned from farming practices
    (1) Meeting basic needs (foods, shelter, clothes) and health services (1) Hiring labour (2) Purchasing of farm inputs (3) buying livestock (4) others (specify): ……
11. If you are not keeping livestock, what are reason(s) for not keeping? (1) Lack of capital for buying livestock (2) shortage of grazing area (3) other(s) specify: ……
12. What are the problems regarding livestock keeping and how do you solve them?

	Type of livestock	Problem	Solution

13. What advice can you provide regarding animal husbandry? ……
14. What advice can you provide regarding crop production practice? ……
15. Where do you get fuelwood for households cooking? (1) Natural forests (2) Buying (2) others (specify): ……do you buy how much per headloads/oxcart(s)…….
16. If is from woodlands, how long do your family members take……..hour(s) and what is the distance covered ……..km/mile.
17. How much fuelwood do you need annually? ……headloads/oxcart(s)
18. What are the factors that have hindered you to adopt agroforestry practice in your farm(s)? ……. ……
19. Is extension officer available in your village (1) Yes (2) No
20. If yes whom one(s) (1) Agricultural extension officer (2) Forest extension officer (3) Others (specify)……..
21. If not where do you get extension services and how often…..……

THANK YOU

Appendix 3: Checklists for key informants

Dear Key Informants,

You have been selected basing on your knowledge so as to provide data/information that could be used to quantify and document the contribution of agroforestry products to household income and poverty reduction in your area. All the information you will provide will be for academic purposes and be treated confidentially.

Therefore you're kindly requested to respond trustfully and faithfully to the following question. I thank you in advance.

A. WEALTH RANKING

1. What are the types of wealth levels/social classes do exist in the village?
2. How these levels are categorized in your village (e.g. possession of certain number of livestock, house roofing type, size of land, certain number of trees etc.)
3. With the assistance of key informants, let each household be categorised (each name of household head obtained from village register is written on each card and categorised by key informants into various social classes/wealth levels).
4. What are the characteristics of each social class/wealth levels
5. What are the factors contributing for an individual or a household to shift from one class to another? That is from low income class to higher income class and vice versa.
6. For the past 10 – 20 years, which agencies from outside the community have helped you to improve your well-being?
7. Can you explain how does agroforestry practice can improve people's well-being?

B. EXTENSION WORKERS

Type of extension worker / Leader……..

1. What is the current trend of agroforestry adoption in the district?
2. Where do farmers get planting materials?
3. What are the existing organization(s) supporting agroforestry adoption in the district?
4. What do they do?
5. Is there any problem of fuelwood/poles/fodder in your area?
6. If there, where do they get them?
7. At what price do they buy?
8. Are there any problem(s) hindering farmers from participating in agroforestry practice? If yes which ones.
9. Is the market of agroforestry farm products (poles, fuelwood, etc) reliable?
10. Where do they sale these products?
11. What can you comment concerning the trend of agroforestry adoption and utilization of products in the village/districts. **THANK YOU**