DISSEMINATION AND ADOPTION STATUS OF AGROFORESTRY PRACTICES IN MUFINDI DISTRICT, IRINGA REGION, TANZANIA

BY

HABIB WALLACE MGENI

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

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ABSTRACT

The current study was carried out during September 2006 to March 2007 in six villages namely Sawala, Kisada, Ikongosi, Sao-Hill, Ihowanza and Igomaa in Mufindi District, Iringa Region, Tanzania. The objective of the study was to determine the extent of dissemination and adoption of Agroforestry by the local communities and indicate the mechanism of scaling up its performance. Specifically it checked on the current status of dissemination and adoption of agroforestry practices, identified Agroforestry systems, technologies, and woody perennials preferred by farmers, determined factors influencing adoption of Agroforestry systems, technologies and find out corrective measures required for improving their adoption by the local communities. The methods used include reconnaissance, social surveys using questionnaires on the household heads and checklists of probe questions on Government and NGOs officials at the various levels from village to the Regional. Data collected was analysed using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel Program (MEP). The results showed that the adoption status of Agroforestry in the district was 65%, although most of the people adopted during the latter 16 years. The main agents that spearheaded the dissemination process included CONCERN, HIMA and various government extension agents. The most adopted agroforestry systems are Agrosilviculture and Agrosilvopasture, with Taungya, Mixed intercropping, and Homegarden being the most widely adopted technologies. Woody perennials species that people currently have shown to prefer are *Eucalyptus* and *Pines.* Insufficiend provision of germplasm, land scarcity and limited knowledge indicated to be the main factors limiting dissemination and adoption of Agroforestry in Mufindi District. Based on the results and subsequent discussion it clear that although encouraging the adoption rate of Agroforestry in the district is still low. The study therefore recommends that the Government should continue with a stepped up provision

of the needed germplasm and propagation materials, farmers need encouragement in establishing their own nurseries, awareness creation especially in relation to inclusion of fertility improving and food producing trees and shrubs be stepped up, further research on the currently unclarified issues and dissemination of available knowledge should be scaled up by both the government and non governmental organisations.

DECLARATION

I, HABIB WALLACE ELIA MGENI, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work, and has never been nor being concurrently submitted for a higher degree in any other University.

______________________________ ______________________
Habib Wallace Eliah Mgeni Date
(MSc. Candidate)

The above declaration is confirmed by,

______________________________ ______________________
Prof. L.L.L.Lulandala Date
(Supervisor)

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DEDICATION

This work is dedicated to my wife Paskazia Mathew and my late son Mathew Mgeni. My wife for the troubles she took towards the fulfilment of my education program. And my son for counsel that he gave me during the last moments of his life. May the Almight God bless them all.

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ACRONYMS AND ABBREVIATIONS

AF	Agroforestry
AFPs	Agroforestry Practices
AFS	Agroforestry Systems
AFTPs	Agroforestry Tree Products
AFTs	Agroforestry Technologies
AIDS	Acquired Immunity Deficiency Syndrome
ANOVA	Analysis of Variance
CABI	CAB International
CGIAR	Consultative Group on International Agricultural Research
DALDO	District Agricultural and Livestock Development Officer
DANIDA	Danish International Development Agency
DNRO	District Natural Resources officer
HIMA	Hifadhi Mazingira Iringa
HIV	Human Immune-deficiency Virus
ICRAF	International Council for Research on Agroforestry
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
KM	Kilometres
LSD	Least Significant Difference
m a .s .l,	metres above sea level
M E P	Microsoft Excel Program
MNRSA	Management of Natural Resources for sustainable Agriculture
MNRT	Ministry of Natural Resources and Tourism
NARO	National Agricultural Research Organisation
NASCO	National Agroforestry Steering Committee
NGO's	Non Governmental organisations
SADC	Southern African Development Cooperation
SAP	Structural Adjustment Programme
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
STD	Sexual transimitted Diseases
TAFORI	Tanzania Forestry Research Institute
UK	United Kingdom
URT	United Republic of Tanzania
USA	United States of America
ZIAP	Zambian Integrated Agroforestry Projects

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Agroforestry (AF) has shown promise with respect to enhanced productivity and system nutrient accumulation in many geographical regions around the world (Chirwa *et al.*, 2007). Increased nutrient inputs, reduction in nutrient losses, and improved soil physical properties are all characteristics of AF as compared to sole cropping systems (Young, 1989; Nair, 1993). The extent of development from these AF systems depends, among others, on careful planning and management to effectively integrate different trees, crops and nimals on different types of Agroforestry practices and technologies (Salam *et al.*, 2000). There are several known Agroforestry systems (AFS) in Sub-saharan Africa of which the most common are; Agrosilvicultural, Silvopastural and Agrosilvopatural systems. Nair (1993), Chianu and Tsuiji (2004) referred Agroforestry practices (AFPs) as specific land management operations and their nature on farm or other management units. In Africa the most common AFPs include; Windbreaks and Shelterbelts, Mixed intercropping and Homegarden (Jama *et al.*, 2003; Odoul *et al.*, 2006; Ajayi *et al.*, 2006). On the other hand Agroforestry technologies (AFT) usually show innovations or improvements through some scientific integration that can be applied, to the management of the systems or practices concerned (Nair, 1993; Russell *et al.*,2004). Tanzania is among the African countries in which Agroforestry has been in place for more than four decades.

AFPs that have persisted in Tanzania include the indigenous and conventional ones. A lot of these AFPs have involved the use of trees either simultaneously or sequentially with the agricultural crops unconsciously for both maintaining soil productivity and to have favourable effect, on crop and the woody perennials (Simmons *et al*., 2002; FAO, 2004).

According to Sanchez (1995) Agroforestry has both ecological and economic interactions between the woody and non-woody components of the system. Among the traditional and conventional Agroforestry technologies which have persisted for a long time in Tanzania include the Chagga homegarden (Ok'tingati, 1985), those of the Haya (Rugalema, 1992), conventional or improved AFPs such as live fences found in the dry lands of central Tanzania. However, Mbwambo (2004), Strong and Jackobson (2006) have cited that people have continued adopting AFTs due to opportunities driven by production in order to generate income. In view of environmental problems confronting small holder farmers in rural areas where emphasis is placed on developing sustainable agriculture and natural resources systems, AFTs can have lasting economic, environmental and social impacts as part of an ecologically based land management system, AFTs can contribute substantially to generating the ecosystem diversity and processes important to long-term sustainability (Kwesiga *et al*., 1999; Franzel *et al.*, 2002).

Tanzania has four Agroforestry zones of which the Southern Highlands zone is one. Others are Lake, Northern and Central zones. The Southern Highlands zone has been prioritized as second in the need for scaling up Agroforestry (NASCO, 2006) Southern Highlands zone comprises four regions namely Iringa, Mbeya, Ruvuma and Rukwa Regions that are commonly known as the *big four* due to their surplus grain production (URT, 1997). The current study was done in Iringa region which comprises of seven districts namely Iringa urban, Iringa rural, Kilolo, Njombe, Ludewa, Makete and Mufindi districts. In Iringa region AFTs have intensively been in place since 1985 to date (HIMA, 2000; NASCO, 2006). Of all these districts, Mufindi district has been implementing AFTs for more than two decades now. However, the status of dissemination and adoption of AFTs is not well established. Jama *et al.* (2003) suggested that enhancing impacts of AFTs requires continuous development and dissemination of innovations, coupled with research and development efforts that improve policies and strengthen institutional delivery practices. It is important to study the dissemination process because dissemination methods and experiences affect organizations ability to reach the local community. The process of dissemination can have as much impact on adoption as the nature of the technology itself (Place *et al.,* 2003). This study assessed the dissemination and adoption status of Agroforestry systems in Mufindi District.

Adoption means the integration of the new concept, idea or technology (Ellis, 1993; Scherr and Miller, 1991). It implies repeated usage overtime and meeting the farmers' specific requirements. It is almost invariably adopted or integrated in the farmers' households. It refers to the ability to make decision regarding the resources and technologies used. A study conducted in Mufindi district (Mdoe and Mvena, 1995; URT, 1997) showed that there were significant variations in the distribution of AFTs in the district among the three different agro-ecological zones. These agro-ecological factors that influence adoption of AFTs include: soil, climate and socio economics.

Agro-ecological zones influence the type of woody perennials that can be grown in an area. In the humid Tropics of Africa, Schroth *et al.* (2001) indicated that there were variations in Agroforestry systems based on soil types. Chirwa *et al.* (2004) and Isac *et al.* (2005) argued that there are temporal changes in the soil, which can influence AFTs. Adoption of Agroforestry technologies in any locality is directly related to economic gains obtained by the community that implements the technology. A study done in western Kenya by ICRAF (2002) revealed that implementation of AFTs was focused on both the soil types and market situation.

Apart from this, there are diverse suggestions on corrective measures required for improving adoption of AFTs by the local community. In their studies (Franzel, 1999; Jama *et al*., 2003; Ssemwanga *et al.*, 2004 and Rahim *et al.*, 2005) suggested that AFTs disseminated to farmers have to be appropriate i.e. tied to other economically beneficial activities that address the expressed need for food security, income generation, risk management, and social objectives of the rural poor and build from knowledge, capital and expectations of local communities.

1.3 Problem statement and justification

Recent assessment done by NASCO (2004) in Iringa Region revealed that there was a high geographical potential for Agroforestry development. The assessment showed that Agroforestry adoption rate in the region\district was 27%. This rate was far below the highest rate recorded of 62.5% for Shinyanga region. The knowledge at which farmers accept and practice Agroforestry may differ due to differences in agro–ecological zones and culture. Mufindi district has three agro–ecological zones (high, mid and low altitude) and three major ethnic groups (Hehe, Bena and Kinga). The uptake of AFTs in these agro-ecological zones and ethnic groupings could have a strong bearing on the dissemination and adoption of AFS and AFTs in the district.

The different traditions and ecological conditions could dictate or advocate different types of AFS and AFTs. The reasons for accepting a technology could differ between areas or cultures. The findings of a study by Ghimire and Pimbert (1997) suggested that since there are various technologies or practices, what has been accepted in one place should not be taken as model in another place. Despite the involvement of farmers in Mufindi district in practicing AFTs the extent to which this innovation has been taken up by the rural community has not been systematically studied, and therefore remains widely undocumented. Most of the tree species planted in these systems are familiar to farmers but poorly documented. This study was, therefore, envisaged to fill this gap and document the dissemination and adoption status of Agroforestry practices in the District. Moreover, any technology dissemination activity takes place in a specific historical, political, economic, agro climatic, and institutional context. The influence of these contextual factors may be crucial in determining the outcome of a particular extension services.

1.4 Objectives

1.4.1 Main objective of the study

Undertaking a systematic survey of Mufindi district in order to establish the status of Agroforestry dissemination and adoption by local communities in the study area and indicate mechanisms of its scaling up to improve its performance.

1.4.2 Specific objectives

The current study intends to;

i. Assess current status of dissemination and adoption of Agroforestry practices.
ii. Identify Agroforestry systems, technologies and woody perennials preferred by farmers.
iii. Determine factors influencing their dissemination and adoption.
iv. Determine corrective measures required for improving their adoption by the local communities.

1.4.3 Research questions

The research questions that will guide the study areas follow:-

- Are there any agroforestry practices adopted by the local communities in Mufindi district.

- What is the current status of AFS in Mufindi district?
- What are the trends of adoption of agroforestry practices and technologies
- What agroforestry technologies commonly practiced in Mufindi District ?
- What tree species do the communities in the study areas prefer?
- When was Agroforestry promotion initiated in the district and trends of its adoption?
- What were the reasons for agroforestry promotion in the study area and levels of achievements of such objectives?
- What extension approaches do you think would be appropriate in helping to promote agroforestry in this area?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Dissemination and adoption of agroforestry

2.1.1 Dissemination of agroforestry

Dissemination of AFTs refer to the spread of AFTs. Various organizations or arrangements and communication techniques that have been used to disseminate ATFs in Mufindi district, which include CONCERN and HIMA (HIMA, 2000). Dissemination agents are responsible to bridge information and knowledge gaps between researchers and farmers who experience low or declining agriculture productivity as well as increasing poverty (Ssemwanga *et al.,* 2004).

Dissemination involves sensitization of farmers and policy makers through seminars, workshops, field visits and extension development programmes. The purpose of technological dissemination is to increase the level and speed of uptake. This is achieved by application of users' information (Feder *et al.,*1985). The Success of AFTs (Ssemwanga *et al.,* 2004) depends on a significant proportion of uptake of the technology, by the farmers. More over the Government strategy on implementation of sound AFTs (NASCO, 2006 ; Ssemwanga *et al*., 2004) is to support the dissemination and adoption of AFTs. However, effectiveness in dissemination will depend on the community or individual or group participation and ability to identify extension needs and request of services that will be influenced by access to information on the production of the AFTs options to the smallholder farmers (Keil, 2005). The role of extension, among others, is: to create a condusive environment through which AFTs could increase productivity and liase with farmers and technology developers and or researchers, making sure that appropriate technologies for the farmers use in a given locality are developed and disseminated

(Haggblade and Tembo, 2004). Extension contacts are a key variable in developing a favourable altitude among farmers towards technological development services (Ajayi, 2006; Mercado and Sanchez, 2007).

2.1.2 Adoption of agroforestry

Adoption means the integration of the new concept, idea or technology. It implies repeated usage of the technology overtime. It refers to the ability to make decisions regarding to resource uses and technologies. The rate of adoption of AFTs varies with regards to preferences within the farming community. These are the key factors in decision making. Sometimes it is very difficult to understand farmers needs and preferences due to local barriers like culture or knowledge and levels of understanding or exposure. Extension staff must understand this so as to influence farmers to make useful decisions. Actual decision arrived at depends on complex bargaining processes among the householder makers (Scherr and Miller 1991; Ellis, 1993). Beyond the household group processes and abilities to harness them can play a crucial role in adoption decision. Ajayi *et al.* (2003) and Barret *et al.* (2006) argued that it is the realization of the farmer's decision to apply the new technology in his/ her production process; where as the final decision is the degree of using the new technology in long run equilibrium of the AFTs. Technological adoption means convention of innovation into farmers adoption of the new technology, it explains the adoption decision that primarily explains adoption in terms of the decision makers perception and the inherent characters.

2.2 Agroforestry sytems, technologies and woody perennials preference

Agroforestry systems usually denote specific land management operations on resource management units and usually consist of various woody perennials, crops and or animals components (Van Noordwijk *et al.*, 2004). The various ways in which the AF systems components are arranged on the resource management units constitute the AF technologies. There are several known AF technologies that include the following (Young, 1997), Shifting cultivation, Taungya, Improved fallow, Alley cropping, Live fences, Windbreaks, Homegarden, Rotational woodlots, Trees on the Cropland, Mixed intercropping and Improved fallow (Nair, 1989 and Mbwambo, 2004).

Agroforesty Technology is a commonly used term in all Agroforestry land use systems. It is usually used in combination with a particular production system e.g. land use system as a prefix (Nair, 1993). The word or suffix technology e.g. AF technology, in this case indicates an innovation or improvement usually through scientific interventions that can be applied with an advantage in the management of the system or practice concerned for example Alley and Hedgerow differentiated through pruning and treaming the foliage. This involves the use of inputs in developing a system or practice concerned (van Noordwijk *et al*., 2006). This implies that the inputs that are used to the development can sometimes be the most significant aspect in improvement of the AFP e.g. fertilizer, pruning (Nair, 1993).

According to Glean (2002) and Ajayi (2006) AFS and AFTs offer many benefits and opportunities including the production of crops, livestock, soil fertility and water availability improvement. They also allow diversification of household revenue sourcses through the production of timber and non timber forest products and thus enhance landscape by promoting biodiversity and carbon sequaration (van Noordwijk *et al.*,2006).

Woody perennials include trees, shrubs, palms, and bamboos virtually everything that is covered by the word trees (Young, 1997). Wood perennials can substantially contribute to mankind and deliver AFTs products or service functions to land, when they are intimately associated with crops or animals (Sileshi and Mafongoya, 2006). This may also include woody plants grown as annuals like Sesbania *spp* (Simons and Leakey 2004; Ajayi et *al.,* 2005; Rogers *et al.,* 2005).

The desirability of woody perennials is a subject of, among others, the purpose of the desired woody perennials. For instance, woody perennials differ in their capacities to improve soil fertility, provide shade, food, timber and overcome wind speed etc. However, literature indicates that farmers' preferences for woody perennials were mainly based on the specific properties such as ability to produce and release high biomass, fuel wood, foliage, litter of high quality and an appreciable nutrient content in the root system when they decay (Ayuk, 1997; Schroth and Harvey, 2004; Haggblade *et al.* 2004; Ajayi, 2006). Thus:

(i) For soil fertility maintenance the woody perennial should have a high rate of leaf biomass production, a dense network of roots with the capacity for abundant mycorrhizal association. An ideal woody perennial must be deep rooted and preferably of the leguminous family due to having a high rate of nitrogen fixation (Nyadzi *et al.,* 2003; Schroth, 2003; Schroth *et al*., 2004). Moreover, its litter must rapidly decay where rapid nutrients release is desirable, or a moderate rate of decay where maintenance of soil cover is required. The preferences expressed by farmers indicate that woody perennials should basically be designated to improve soil fertility, which indirectly raise crop yield and increase household income (Haggblade *et al*,. 2004).

(ii) Farmers' preferences were seen to be very specific to the type of woody perennials to be included in their farmland. However, the authors reported that choice of woody perennials was based on the specific needs of the households.

These needs included soil-improving characteristics for livelihood improvement (Lulandala, 1998; Chirwa *et al.,* 2003; Rogers *et al.*, 2005).

(iii) Easiness in plant establishment e.g. direct sowing - a method that eliminates the need for nursery operations and hence reduced time and labour requirements (Chikoye, 2002; Ajayi, 2006; Harum *et al.*, 2006). Farmers also prefer woody perennials like *Eucalyptus* that re-sprout or coppice after being cut. This advantage eliminates labour that would otherwise be required to re-establish the Agroforestry systems.

(iv) Farmers give preference to species that have short payback periods as for those that are less prone to attacks by pests and fire for example *Eucalyptus* and *Sesbania spp* (Simmons and Leakey 2004; Rogers *et al.*, 2005; Oduol *et al.*, 2006).

(v) Fruit trees are also preferred for nutrition and generation of income. Moreover, farmers prefer those species that have large quantities of marketable seeds or fruits like peaches (Rogers *et al.*, 2005; Kristjanson *et al.*, 2005). This could be an indication of the farmer's desire for immediate food security and cash income, while they wait for the benefits of soil fertility improvement.

According to Oduol *et al.* (2006), woody perennials that are being promoted for soil fertility improvement, especially for the dry tropical zones like Shinyanga in Tanzania, include *Acacia crassicarpa, Acacia.leptocarpa, Acacia.jutifera, Acacia.polyacantha, Acacia nilotica, Leucaena lecocepha, Azadirachta indica, Gliricidia sepium, Sesbania* *sesban, Tephrosia vogeli, Tephrosia candida* and fodder banks for livestock improvement include *Gliricidia sepium , Acacia .angustissima, Leucaena pallida, Calliandra spp*

The roots of woody perennials in Agroforestry systems also stabilize the systems by checking soil erosion, maintaining soil organic matter and various soil physical properties (Young, 1997). They, in addition, influence the systems' nutrient cycling and nutrient input through various ways including nitrogen fixation (Schroth and Harvey 2003; Chirwa *et al*., 2004). They are similarly useful in ameliorating environmental conditions and carbon sequesteration (Nair and Nair, 2003).

2.3 Factors influencing the dissemination and adoption of AF

There are several known factors that have been observed to affect dissemination and adoption of AF practices in rural areas (Jaggier and Pender, 2003; Ssemwanga *et al.*, 2004; Boz and Akbay, 2005), including lack of extension services, inappropriate functioning of the input markets, gender, perception of the decision maker, age and experience of the farmer, farmers' education, farmers' income, technology characteristics, labour, land tenure and time horizon, species preferences, risks and stabilities, policy supports, farm fragmentation and other factors.

2.3.1 Lack of extension services

Extension services are critical components in development, across a wide range of issues, including natural resources management, agricultural productivity, health and sanitation, and watershed management (Place 1995; Place and Dewees, 1999). In order for development of AF to be successful, a holistic approach is required. Multifunctional extension programmes are useful strategies for accomplishing integrated rural development, and can include environmental, economic, health, and agricultural productivity goals.

Extension workers are not only responsible with Agroforestry dissemination but also to strengthen human and social capital such that farmers can continue the dissemination process from one point and ultimately in other areas (Böhringer *et al.*, 2001; Reed, 2007). This shows that the process of dissemination can have as much impact on adoption as the nature of the technology itself. Thus it is important to understand different approaches used by different organizations, people's perceptions of the implementation in practice and the effectiveness in achieving the objectives identified (Franzel *et al*., 2002; Place *et al.*, 2005). Lack of extension workers and insufficient time for farmers to learn may seriously affect dissemination and adoption of AFTs. The realization of appropriate AF dissemination methods and experiences enhance the ability to reach the poor farmers (Böhringer *et al*., 2003).

2.3.2 Inappropriate functioning of input markets

According to Ssemwanga *et al.* (2004) technology dissemination entails not only training the would be users, but also making the technology available to the users. Input markets are part of the dissemination process on the landscape and so are the policies that affect the efficiency of these markets. The limited investment in AFTs development is due to inefficiencies in the input market. Bibangambah (1996) observed that the sluggish market growth of AF is partily attributed to the lower AFTs status; this may also result in lower participation of AF investors. The market current situation have to some extend distorted the market and make AFS less attractive to investors. The low demand discourages new entry of AF Adopters.

2.3.2.1 High input prices

High prices of Agroforestry inputs may suppress demand of these inputs, and result to reluctance to invest in measures that might increase dissemination and adoption in AFTs. According to Ssemwanga *et al.* (2004), high prices in Agroforestry are due to several factors including high transaction costs in input trading caused by a thin market (low trade volume), and high transaction costs caused by other running costs. The adoption of AFTs that require high labour input can be enhanced or dettered by the availability or lack of complementary labour saving AFTs.

2.3.2.2 Poor rural accessibility

Many extension service providers tend to operate in areas that are easily accessible. They do not go to remote areas that not only have the biggest population but as well the demand for extension services is high. It is, therefore, harder for farmers in remote areas to access technical assistance (Scherr, 1992 ; Van de Fliert, 2000).

2.3.2.3 Infancy as a cause of input market inefficiency

According to Nkonya and Kato (2001) business transactions of Agroforestry products take place in both the local and international market. Although these markets have been developed for AF products, they are still in an infant state and operate inefficiently. This phenomenon may have a strong bearing on AF dissemination process. However, the effectiveness in the dissemination will depend on the community or individual groups in being able to identify extensional needs and services that will be influenced by access to information on technologies options available to smallholder farmers (Ssemwaanga *et al.*, 2004; Keil *et al.*, 2005). Extension workers among others, produce technologies intended for increased AF productivity. Extension contact is a key variable in developing a favourable attitude among farmers towards the technology (Ajayi *et al.*, 2005).

2.3.3 Gender

This is the existing power relation between men and women, which influences the adoption of new AFTs (Kabuta, 2002). In most African communities agroforestry is no exception in terms of roles of men and women in implementing the technology (Gladwin *et al.,* 2002). Gender of the household head plays an important role in the productivity of smallholder farming systems (Kerkhof and May, 1988). Differences in the household's access to land and labour resources, financial and commodity markets, significantly influence cultivated land size, kind of crops planted (Phiri e*t al.,* 2004). The gender differences manifest in decision-making, land tenure rights and access to productive resources. However, studies by (Ajayi *et al.*, 2003; Franzel *et al.,* 1999; Keil, 2001) show that there are no significant differences between the proportions of men and women implementing AFTs. However, in certain cases, some married women may not establish improved fallows without the consent of their husbands (Kerkhof and May, 1988 and Peterson, 1999). Apart from this Franzel *et al*. (2002) advocated that in some communities, improved fallow plots planted by women headed households were significantly smaller than those planted by men male headed households due to greater land and labour constraints or risk aversion. Furthermore, in most of African societies women farmers get lower crop yields than men; but this is due to differences in the intensity of input use such as inorganic fertilizers, labour, credit, and extension education (Rwelamila, 1999).

2.3.4 Perception of the decision maker

The decision of adoption depends on complex bargaining processes among the household makers. These processes can go beyond the household group (Cramb, 2004; Moser and Barret, 2006; Doss, 2006), and ability to harness them can play an important role in adoption decision. The final decision is the degree of using the new technology in a long run. The decision makers' perception and the inherent characters of AFTs are important aspects in this context (Drechsel *et al.,* 2004; Schüller *et al.,* 2005). In order to have effective adoption a farmer, must first recognise the existence of the problem (Scherr and Miller, 1991; ICRAF, 2002; Sood and Mitchel, 2004; Kristjanson *et al.,* 2005), which may either be food, soil erosion, or crop failure. These depend on personal experience. Once it is perceived the farmer who decides which methodology to adopt (Senkondo, 2000).

2.3.5 Age and experience of farmer

The age and experience of the farmer may likely have a range of influences on household's adoption decision. Old age may for example, influence the farmer in the direction of not adopting (Ghadim and Pannell, 1999; Marenya and Barret, 2006). As decision makers, the planning horizon shrinks with age and so incentives for them to invest in the future productivity of their AFTs diminish. Younger farmers may incur load switching costs in implementing new practices since they have limited experience in the learning and adjusting costs of new technologies involved (Peterson and Pritchard, 2002). Similarly, AFTs require more physical effort of relatively healthier and strong young farmers who are more likely to adopt a new technology because they have had more schooling than the older generation or perhaps have been more exposed to new ideas than their counterparts (Thangata and Alavalapati, 2003). A study conducted by Senkondo *et al.* (1999) in Western Pare Lowlands of Tanzania, however, found that, farmers with more experience in farming were more able to adopt rainwater-harvesting technologies compared to those with less experience.

2.3.6 Farmers education

The farmer's educational background is an important factor in determining the readiness with which to accept and properly apply a new technology. According to Maddala (1983) education broadens horizons beyond habits and traditions of individuals, encouraging involvement of an individual in development activities. Therefore through education, an individual becomes more critically aware of the need and scope for social change (Rahim *et al*., 2005). More years of formal education is associated with high level of comprehension of new technologies. For example an educated farmer will likely be more able to use high yielding varieties, insecticides and pesticides. Thus, attainment of education is an important tool for enhancing AFTs adoption (Machumu, 2002).

Furthermore, Scherr (1995, 1999) reported that, resources might be well managed by people if they have education, and through education farmers may know the rationale for taking care of their environment from the point of view of their farming practices and other socio-economic factors. On the other hand Senkondo *et al*. (1999) revealed that, adoption of rainwater harvesting technologies in Western Pare Tanzania is not significantly explained by education but rather other factors such as experience in farming and perceived technology characteristics.

2.3.7 Farmers income

According to Scherr (1995) and Franzel (2004) agroforestry income generating activities are the farmers' sources of income to meet the basic necessities. These sources could include selling of own farm produce and off farm activities. Crop production alone does not fulfil the requirement for survival for the majority of rural households (Thangata and Alavalapati, 2003). Farmers with more sources of income can be more readily to afford and or purchase chemical fertilizers than those with limited sources. This is is especially the case in the semi-arid areas where seasonal crop failures are common (Jama *et al.,* 2003). It is hypothized that farmers with more sources of income are less likely to adopt AFTs. As a result rural households tend to diversify their sources of livelihood. According to Cramb and Culasero (2003), diversification of sources of rural livelihood can have a positive impact on livelihood by reducing the risk of a household being confronted by income failure.

In developing countries the challenges associated with poverty and environmental degradation are closely linked. Livernash and Rodernburg (1998) noted that a farmer living in abject poverty could easily let the immediate need to produce food outweigh the long-term benefits of conserving the land. Farmers with high income are more likely to be adopters of new practices than farmers with low income, as income increases the farmers' ability to hire labour and meet costs associated with technology requiring increased demand for labour or other inputs (Casey, 2001; Cramb, 2005a). A study conducted in Kilimanjaro by O'kting`ati (1985), revealed that, 92.7% of farmers of Kilimanjaro accepted trees as being useful in their farms. AF created higher employment opportunities than for other monoculture and from a profitability point of view, AF is superior to other forms of land use.

2.3.8 Technology characteristics

Farmers make decisions to adopt technologies upon benefit consideration and will adopt new AFTs only if their benefits exceed the old ones (Ajayi, 2006). Senkondo *et al.* (1999) found that perceived technology characteristics of rainwater harvesting technologies in increasing yield positively influenced their adoption in Western Pare, Tanzania.

2.3.9 Labour

Labour is often a major limiting resource for many farmers, so they will only change their traditional practices where the alternatives represent a more rational use of their labour and time (Brown and Schreckenberg, 1998). AFTs require labour input from households, they are intended to make better use of resources such as labour, and their initial adoption will most likely entail greater total labour effort from the household. It has been reported by Franzel (1999) and Rahim *et al*. (2005) that labour constraints are critical in farmers' use of Agroforestry technologies. Labour requirements are widely regarded as a critical element in influencing adoption of Agroforestry practices because their applications are sometimes labour intensive.

Although the lack of fertile land can be the prime constraints to technologies adoption, such as in the case of planted follows in densely populated Rwanda, labour is still considered a major constraint especially to "low external input" technologies (Blarel *et al.*, 1992). Consequently, it is very important to take into consideration all of the changes in labour implied by any suggested technology. Labour availability and labour bottlenecks are two of the most important types of diagnostic information that aid in selecting appropriate technologies and in defining target groups with high adoption potential (Thangata and Alavalapati, 2003). If labour is scarce at particular peaks, extreme caution must be used in experimenting with technologies that may further increase the labour demand at that time.

As many roles and tasks are for cultural reasons and gender –specific, any labour analysis has to be gender sensitive (Natai, 2004). Annual migration patterns of youth from rural areas to urban centres have reduced, in many regions, seasonal farm labour availability emphasizing the temporal importance of labour productivity. Maintenance, on the other hand, requires little input. Consequently, the set-up of such "best practices" is a luxury for families who are short of labour unless they can pay for additional (hopefully available) help, or can use the services of the local community (Mercer, 2004).

2.3.10 Land tenure and time horizon

Evidence from many parts of the world suggests that lack of control over resources is one of the major reasons for the degradation of natural resources (Place and Swallow, 2000). In open access rangelands, the “tragedy of the commons” paradigm holds that an individual behaving in his own self-interest will continue to exploit a common resource, even when it is being overused and degraded because the benefit from that behaviour accrues to him alone, while the constraints are divided among members of the community as a whole (Unruh, 2002). Thus, the resource base is ultimately doomed to destruction (Tedonkeng and Pieper, 2000). This paradigm seems to have been over-simplified and fails to consider a number of alternative incentives to individual behaviour. However “tragedy of the commons” abounds, as witnessed by degraded conditions of many rangelands under free and open assess system in Sub-Sahara Africa and elsewhere in the world. Rogers (2003) reported that farmers’ control of and access to land and labour are major factors limiting the uptake of technologies.

Certain technologies such as AF are inherently long-term, requiring security of tenure over land for an extended period of time (Workman and Nair, 2004; Ajayi, 2006). Many farmers are resources-poor and may lack land security, thus, are unable to invest in such technologies. But even where tenure security is given, benefits might only accrue after some years (Derpsch, 2005). This might be the reason why studies of the privatization of land have not shown to automatically lead to increased investment and more sustainable practices (FAO, 2003). In such cases to facilitate adoption of any AFTs measures, short-term benefits or incentives are required, even if they compromise.

2.3.11 Woody perennial species preference

Woody perennial species are not ubiquitously distributed on the landscape. There is a great variation in distribution amongst woody perennial species found on each habitat. Their natural distribution is controlled mainly by edaphic factors, the amount of precipitation and the means of dispersal (Munishi *et al.,* 2004). However, there are few species that have got a wider range of environmental conditions and thus they are more widely distributed than other species. Perhaps this is due to a wider range of species tolerance to the wide range of environmental fluxes while the rest of the species are confined to specific environments and hence, therefore, they are not found in every ecological conditions .e.g. high rainfall, high altitude, alkaline soil and deserts (Munishi *et al.,* 2004). In most cases smallholder farmers prefer to plant trees that they are familiar with, multipurpose , fast growing and/or have short-term return, such as fruit trees, rather than trees that have long-term maturing periods such as timber trees (Rogers *et al*., 2005; Wambugu *et al*., 2006). Generally farmers prefer woody perennials that are fast growing and produce good quality timber, have ability to do well even in poor soils, have ability to sprout or coppice when subjected to cutting or burning, or can be sold as poles, firewood, and timber (Ajayi *et al.,* 2005; Oduol *et al.,* 2006).

2.3.12 Risks and Stability

Farm enterprises are among those management systems where disturbances are regular. Yield fluctuations usually occur due to erratic rainfall, floods, insect attack, diseases etc (Shvely, 1999). To the extent the farmer succeeds in minimizing such risks and uncertainties, he succeeds in maintaining his returns. Common examples of risk management are possession of large herds of livestock or the use of mixed (local) crop varieties instead of a promoted one (Franzel, 1999). Risks and uncertainties affect the farmers` attitude towards innovations and their adoption behaviour and have to be analysed in a participatory way. Especially low-wealth farmers are often reluctant to adopt technologies because they need stable income especially when returns to adoption are unclear or will only bear fruits in the future. An example for an innovation related risk is the introduction of a soil protecting green manure as a (partial) substitute for cowpeas or groundnuts in the minor rainy season (e.g. in Rwanda and Ghana) (Blarel *et al.*, 1992). This might reduce the availability of protein rich food for the family, seeds for next reason and also affect the gender specific distribution of income (Place and Dewees 1999; Doss 2006). All can cause instability at different levels and may result in non- adoption of technologies. Also interventions actually aiming at risk reduction might be counter-productive to conservation measures, like improved livestock health programmes or additional boreholes for stock water (Senkondo *et al.,* 1999).

2.3.13 Policy support

The preceding analysis of the financial and other factors associated with the adoption of conservation technologies and related practices has already captured many opportunities on polices that could support adoption (URT,1998; Mercado *et al*., 2001; Ajayi and Kwesiga, 2003) 'Governments can use macro-economic policies, trade regulations or education and extension to alter the decision-making environment in which farmers choose one practice over another (Place and Dewees, 1999). However, many programmes promoting conservation have been relatively ineffective because of contradictory signals and incentives from other policies designed to promote sustainable agriculture, for instance agriculture, can be undermined by others, typically richer or short term benefits, in support of highly erosive cash crops or by weak or slow to respond to research and extension efforts (FAO, 2003; URT, 2005).

2.3.15 Farm fragmentation

According to Pope and Prescolt (1985), Blarel *et al.* (1992) and Rahim *et al.* (2005), AF technological development takes place in two different kinds of land holdings; the consolidated and fragmented. A consolidated land holding is the phenomenon where AFTs development takes place in an amalgamated land and re-allotment of plots, while fragmented land holdings occur when a household operates in more than one separate parcels of land. The latter is a common phenomenon in Sub Saharan Africa. A similar view to farm fragmentation is expected to have a positive effect on both adoption and continued adoption as farmers who have more fragmented plots; can leave some plots under AFs and cultivate annual crops on the other plots. Conversely, Prescolt (1985); Sahakya (2003) who observed that the impacts of farm fragmentation in Armenia had detrimental effects on sustainable natural resources conservation and socio development in rural areas. They further observed that when land parcels are merged (consolidated) they are better shaped and reduced in number, resulting in better farming conditions that allow opportunity for specialization and mechanization. Also the distance between farm locations and land parcels will decrease resulting in less labour input saving energy and less operation costs. It is thus noted that land consolidation may have positive effects and thus likely to favour AFTs adoption.

2.3.16 Mode of land acquisitions

In most African societies land acquisition usually takes place through inheritance, some by rental arrangements in which cash payments exist or crop sharing and free use from the community land. Farmers might, therefore, operate one or more inherited plots, one or more purchased plots, and one or more rented plots, one or more freely allocated plots at the same time (Blarel *et al.*, 1992). Thus, the types of land acquisition methods and rights over resources may be quite uniquely defined within local areas. To find the basis for comparison and extrapolation, it may be necessary to find common characteristics to rights and acquisition methods. For example, what might be defined as renting may actually differ significantly from site to site. However, Place and Otsuka (2002) observed that transferability of land rights, including rental, bequest, temporary and permanent gift, and sale, may affect AFTs adoption in two ways. First, restrictions on transferability may reduce the incentives of current residents to adopt technologies likely to generate benefits beyond their likely tenure. For example, if an elderly man cannot pass a piece of land to his heirs, then he is likely to exploit existing trees rather than plant new trees. Second, restrictions on transferability are likely to reduce the market exchange of land and thus may affect the efficiency of land allocation (Place, 1995; Pali *et al*., 2004).

2.3.17 Other factors

Other factors include profitability, feasibility and acceptability (Ajayi *et al.*, 2003; Scherr and Miller, 2004). Moreover these authors further stress that adoption of AFTs could be regarded as a continuum in which individual farmers are conceptualized to occupy positions in the adoption continuum depending on the extent to which they have taken up various components of the technology (Swinkels and Franzel, 1997; Pannell, 1999). Feasibility concerns whether farmers are able to manage the technology that is whether they have the required information and resources and are able to plant and maintain the AFTs (Koech 2005). Profitability is whether, from the farmer's perspective, the financial benefits obtained from using the technology are higher than for alternative technologies, including the ones farmers use (Pali, 2003). Acceptability concerns whether farmers want to use improved AFTs that is whether they perceive greater advantages than disadvantages from using them. Acceptability thus includes a range of criteria in addition to profitability and feasibility, such as risks, suitability to accepted gender roles, cultural acceptance, and compatibility with other enterprises (Peterson *et al*., 1999).

2.4 Corrective measures required for improving dissemination and adoption of AF

The highly, successfully and widely adopted agroforestry technologies can be achieved by seeds and seedlings provision by the Government, formation and strengthening of the existing AFTs farmer groups, active promotion of AF by extension workers and development of a wide range of AFTs.

2.4.1 Seeds and seedlings provision by the government

Smallholders' tree planting activities are often restricted by limited access to quality planting materials, poor nursery skills and a dearth of appropriate technical information (Aalback, 2001; Gunasena and Rushetko, 2000). Tree seeds are a key input for promoting AF. Deliberate efforts must be embarked in conducting studies on quality germplasm of appropriate species which are important for effective innovation and intervention, particularly for smallholders farming (Simons and Leakey, 2004). Efforts must be made to link smallholders with the sources of quality germplasm and expand smallholder access to a wider range of species that are suitable to the biophysical and socioeconomic conditions they confront (Michon, 2005). This should include developing farmers' tree propagation and tree nursery management skills. However, farmers may often be a primary source of tree seeds, operating seed collection enterprises at the family or farmer group levels (Cromwell *et al*., 1993; Simons *et al*., 1994). Based on orders for specific quantities and species, farmers may collect, dry, clean, grade and even package tree seeds for the market. Some individual farmers and farmer groups even plant trees for the purpose of seed production.

2.4.2 Formation and strengthening farmers groups

According to Scherry (1995, 1999) smallholder farmers generally have weak market linkages and poor access to market information. Farmer groups are an effective means of reaching a large number of farmers at the same time. The formation and maintenance of farmer groups is not an objective in itself. Farmer leaders training workshops focus on priority species, systems, problems, market and/or other priorities (Scherr, 1999; Mercado *et al.*,2007). Common skills which could be provided include seedling propagation and nursery management, tree and AF system management, farmer–market linkages, and farmer-operated commercial enterprises. In most circumstances, additional opportunities exist for individual farmers or farmer groups to form businesses or associations that focus on one or more of the activities that can either be unified to solve problems related to transportation or wholesale and other mid-channel activities essential for AFTs development (Carandang *et al*., 2006; Tukan *et a.,l* 2006).

The farmer to farmer networks can lead to spontaneous technologies adoption, spontaneous farmer-to-farmer extension, and expansion of the whole AF programme development (Harum, *et al.,* 2006; Reed, 2007). Experience indicates that the greatest impact is achieved through the development of farmer specialists who intimately understand the conditions and concerns of fellow farmers. Their language and communication styles are readily understood by the fellow farmer participants (Honlonkou, 2004).

2.4.3 Active promotion of AF by extension workers

Government workers should take the leading role in the provision of AF extension services. The training of the farmers and helping them to identify appropriate local priorities, is very valuable in motivating their participation unlike the top-bottom approach which was previously employed in the dissemination process of AFTs and proved not effective in delivering the required services in the rural smallholders (Mercer, 2004; Harun *et al*., 2006). In order for extension servise to be effective there should be proactive involvement of farmers in the technology development process in the ensuring the appropriateness of the technologies developed (Rushetko *et al.*, 2004a).

Extension workers have to ensure that they provide a mearningfull learning that stimulates desire to change and therefore seek for new knowledge and technologies this may largely depend on the competence of the facilitators and their regular contact with farmers. They have to challenge farmers to aspire for improvement in their practices and link them to market chains and supporting agencies (Ssemwanga *et al.,* 2004).

2.4.4 Development of a wide range of AFTs

Efforts should seek to develop a range of management techniques for various AFS and AFTs that enable farmers to produce quality products for specific market opportunities (Hammett, 1994). Diversified AF species that are more productive and marketable e.g. wild fruit trees ought to be incorporated and improved with Exotic species as for those belonging to the *Fabaceae* family may be promoted for nutrients replenishment in the soil for sustainable production (Ajayi, *et al*., 2007; Rogers *et al.,* 2005).

2.4.5 Government support on land tenure and policies

AFTs development takes place on various land holdings thus reflecting different characterics i.e. different tenural and policy systems on the land parcels. Appropriate land tenure and government policy support, are basic enabling conditions required to facilitate the development of a wide range of AFTs on the smallholder land management systems (Roshetko *et al*., 2006). Developing supportive land tenure and policy conditions often requires broad-based negotiations that include participation from the local, regional and national governments as well as the private sector and community based organizations in enhancing AF development (Fay *et al.*, 2005; URT, 2005).

2.4.6 Enhancement of smallholder management skills

The productivity of most smallholder AF systems can be improved by enhancing smallholder management skills. Key skills include: species selection versus site matching; identifying tree management systems that match farmers' land availability, labour, socioeconomic limitations and the existence of accessible markets for tree products. Otherwise, the development of economically viable systems is doubtful (Landell-Mills 2002; Roshetko *et al.*, 2004 b).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

3.1.1 Description of the study Area

The study was conducted in six villages namely Sawala, Ikongosi, Kisada, Sao-Hill, Ihowanza and Igomaa of Mufindi District in Iringa Region. The selection of the study area was based on the fact that the region is one of the major grain producers' in the country (URT, 1997) and had been implementing AFTs for many years. In addition the government has made efforts to invest on awareness creation through various projects and programmes for more than three decades (HIMA, 2000; Sosovelle *et al.*, 2002).

3.1.1.1 Geographical location

Mufindi is amongst seven Districts of Iringa Region, which is part of the Southern Highlands of Tanzania. It covers 7125 square kilometres and lies approximately between latitude 8^0 6' and 8^0 92'S South of the Equator and between longitude 34^0 35'E and 35^o 35' East of Greenwich Meridian. It is borded by Iringa District to the North, Kilombero and Ulanga Districts of Morogoro Region to the east, and Njombe District in the South and Mbarali District in Mbeya Region in the west (Figure 1). It is about 90 Km south of Iringa Municipality and 570 Km southwest of Dar es Salaam. The district is divided into five divisions namely Sadani, Malangali, Ifwagi, Kasanga and Kibengu with 28 wards, which are further subdivided into 132 villages (URT, 1997).

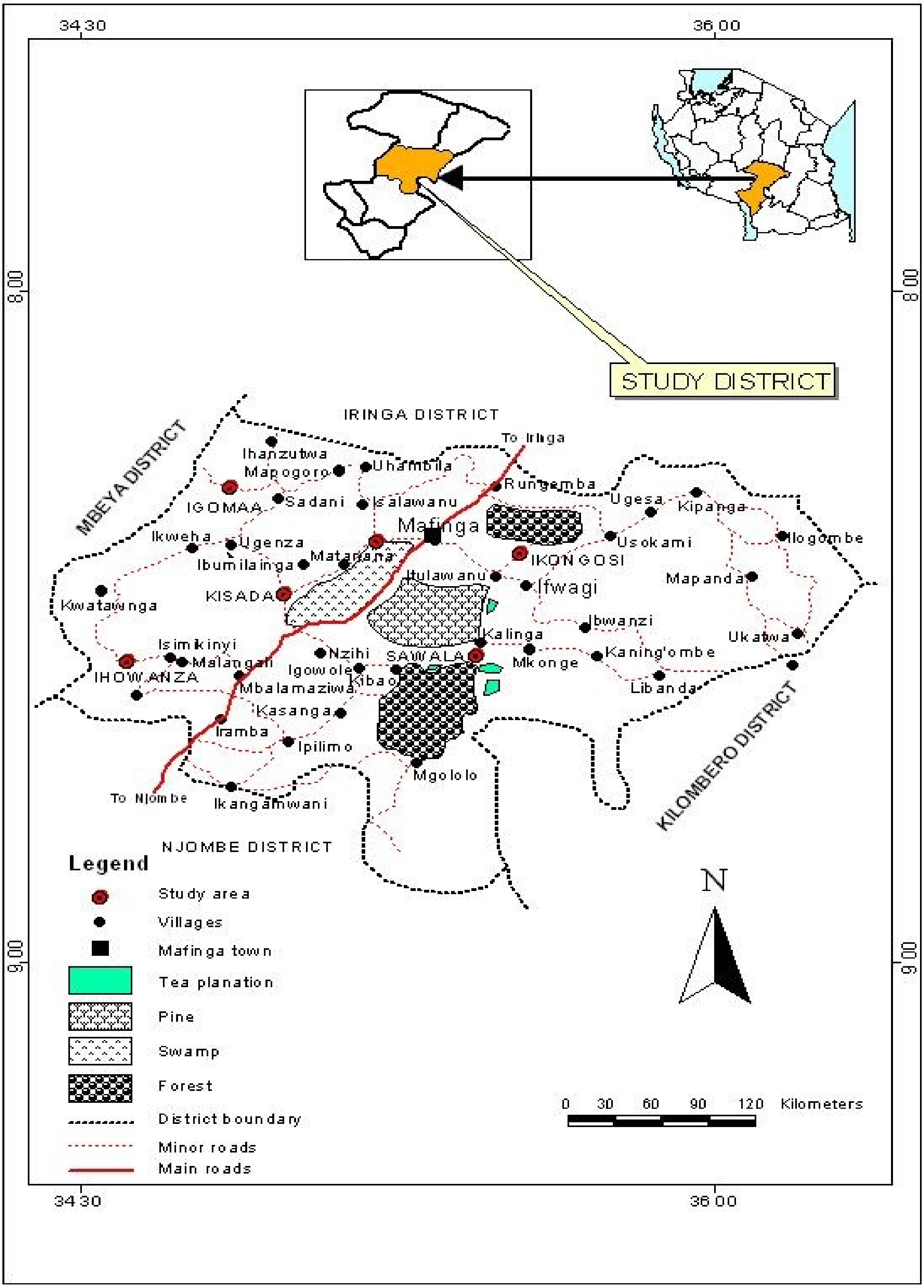

Figure 1: Map showing location of Mufindi district

3.1.1.2 Climate and agro-ecological regions

According to URT (1997) the District is delineated into three topographic zones; the highland, midland and the lowland zones. The climatic conditions and soils of the district are closely associated with the existing three distinct landscape zones. The higher agro-ecological zone lies between 1600 and 2700 metres above sea level (m.a .s .l); this includes the eastern zone with an average temperature of 15^0C and annual rainfall ranging from 1000 to 1600 mm. The mid agro-ecological zone lies between 1200 and 1600 m a .s .l with mean temperatures between 15 and 20^0C and rainfall ranging from 600 to 1000 mm annually. The lower agro-ecological zone lies within an altitude of 900 and 1200 m.a.s.l. and temperatures between 20 and 25^0C with rainfall ranging between 500 and 600 mm annually. Generally, the rainfall pattern is unimodal with a single rain season, which starts in November to mid April or May with the prolonged dry season between mid May to October. The soils are varied including well-drained and moderately red to deep red, yellowish sand and loam (URT, 1997).

3.1.1.3 Population and ethnicity

According to the 2002 population census (URT, 2003) the population of Mufindi District was 430 992 in which males were 282 071 and female 148 921 with an average members per household of 4.8, and an annual growth rate of 2.8%. More than 90% of the people live in rural areas. The main ethnic groups are Hehe, followed by the Bena, Kinga and Pangwa tribes.

3.1.1.4 Economic activities

The economic activities in these zones are principally agricultural based with farming being their major occupation and the area cultivated is 1691.475 Km^2 (23 %) of all the district area). Food crops grown included maize (*Zea mays)* wheat (*Triticum aestivum*,) sweet potatoes (*Ipomea batatus*), sunflower (*Herianthus anus*), Irish potatoes (*Solnum tuberosum*), and cassava (*Manhot esculenta*) mpunga (*Oryva sativa)* and beans (*Phaseolus vulgaris).* Cash crops included pyrethrum (*Chrysanthenum cinerariafolium*) and tea (*Camelia sinensis).* While livestock keeping is practiced on small scale, types of livestock include cattle, goats, pigs, guinea pigs, sheep and chicken. Non- farm activities included carpentry, masonry, traditional healers and petty businesses for men and women.

3.1.1.5 Conservation status

Afforested land is 47 338 ha (6%), dominated by pine and eucalyptus species as well as black wattle. Miombo woodlands currently occupy 80 000.ha (11%), dominated by the *Braychstegia speciformis, Julbernadia globiflora, Braychstegia boehmii, Compretum molli, C. collinum* and *Terminalia sericea* Wetland forests occupied 16 690 ha (2.3 %).

3.2 Methods

3.2.1 Sampling procedure

The district was purposevily stratified into three zones based on altitude (900-1200, 1200-1600 and above 1600 m a.sl. for low, mind and high zones respectively. In each zone two wards were randomly selected to constitute six sampling wards, out of 28 wards found in the Mufindi district (8 , 9 and 11 wards, for the low, mid and high zone respectively). The essence of stratification was aimed at getting parts of the landscape that are more or less homogenous. Subsequently one village per ward, twenty households per village were randomly selected for detailed study thus making a total of 120 sample households. A random sampling technique was preferred in order to avoid bias and provides equal opportunity for each household to be selected for inclusion in the total area of a sampled population and will frequently provide essential information’s at low cost than completed enumeration (Freese, 1984; Synott, 1979; Kothari, 2004). The sampling frames for this study were the village registers containing the list of household. Respondents were selected by matching their number in the village register with the first three numbers in the table of random numbers.

3.2.2 Data collection

3.2.2.1 Reconnaissance survey

Reconnaissance survey was conducted in order to provide a general picture of the study area. During reconnaissance survey, two villages namely: Itulavanu and Idetelo villages were selected and used to test questionnaires and familiarise with the study area in which twenty households were sampled, ten from each village.

3.2.2.2 Social survey

Primary data

A representative sample size of 120 households from six villages was taken, this has been adopted from Matata *et al.* (2001) who advocates that 80-120 respondents are adequate for most of the social economic studies in Sub Saharan Africa households. Structured questionnaires were used to collect data on the status of dissemination and adoption of AFS and AFTs (Appendices 1-3). In addition data on type of AF systems, AF technologies and woody perennials preferences were investigated using the questionnaire. Key Informant interviews using a checklist of probe questions was also used to enrich the information obtained from the questionnaire survey. Both open-ended and closed ended questionnaires were used.

Focused group discussion

In this regard, key informants included the following; district officers, village leaders, elders, Sao-Hill afforestation project village and ward officers, extension officers and non-governmental organisations Appendix 2. The study took a quantitative and qualitative approach with an extensive use of key informants' interviews. The perceptions and behaviour of respondents on the status of dissemination and adoption of AFTs were established. An attempt was also made to revisit unpublished literature and reports in the district councils, projects and NGOs offices, relevant to the subject matter and the study area.

Secondary data

Secondary data was obtained at District agricultural and natural resources offices of Mufindi district council, and Sokoine National Agricultural Library (SNAL). Online databases and documents were also visited as shown in the bibliography.

3.2.3 Data analysis

The quantitative and qualitative information collected through structured questionnaires were coded to facilitate data entry, statistical analysis and interpretation of percentage data were done by first converting them into arcsine angle values and then subjecting them to standard computer software, specifically the Statistical Programmes for Social Sciences (SPSS) 11.0 version for MS Windows and Microsoft Excel. Cross tabulation was used to compare observed variables under investigation. Two-way Analysis of Variance (ANOVA) was used to determine whether there were significant differences between parameters studied. The Least Significant Difference (LSD) was used for comparing treatment means (Kothari, 2004).

CHAPTER FOUR

4.0 RESULTS

4.1 Status of dissemination and adoption of agroforestry in Mufindi district

4.1.1 Status of agroforestry adoption

The results on agroforestry dissemination and adoption in Mufindi District are presented in Table 1. The detailed data including the associated statistical analyses are presented in Appendices 4 - 17. It will be noted that, until the time of the study, on the average 65% of the population in Mufindi District had adopted Agroforestry and the adoption rate is more or less evenly spread throughout the District (Appendices 4 -7).

Table 1: The level of AFTs adoption in Mufindi District as by the year 2007

Agro-ecological zones	Percent
Higher altitude zone	76
Mid altitude zone	55
Low altitude zone	66
Average	**65**

4.1.2 Trend of dissemination and adoption of Agroforestry over the period 1970-2007

The results on Table 2 presents the dissemination and adoption trend of AFTs in Mufindi District over the past 36 years and their statistical details are provided in Appendices 7- 10. It will be noted that AF dissemination in the district started during the 1960s period. The adoption trend started gradually during the initial 20 years and drastically accelerated during the latter 16 years, probably due to more greatly sensitized communities and the observed systems' benefits.

Table 2: Agroforestry dissemination and trends of its adoption by the Mufindi District communities (1960-2007)

Year	Percent
1970	3.3a
1980	5.0b
1990	24.2ab
2000	51.7bc
2007	65.0c

The Means in the same row that followed by the same letter do not differ significantly (P > 0.05)

4.1.3 Facilitating agents for agroforestry dissemination in Mufindi District and the accompanying impacts

The results on Table 3 present the various agents that were responsible for agroforestry dissemination services in the District. The relative impacts towards the dissemination were statistically significant P<0.0089961. CONCERN, the Government extension agents (agricultural and forest Extension Officers), HIMA and Sao Hill Plantations Project in that order played a major role.

Table 3: Agents responsible for Agroforestry dissemination in the Mufindi district

Agents	Percent
CONCERN Project	34 a
Foresters and Agricultural field officers	18a
HIMA project	15ab
Sao Hill Project	13bc
Meetings	7c
School	6c
Seminar	4c
Parents	3c
Total	**100.0**

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

The results on Table 4 show the periods of operation by the various major facilitating extension agents in Mufindi District. While CONCERN had the shortest period of operation, had imparted the greatest impact in agroforestry dissemination (i.e. 34%).

Table 4: Periods of operation by the various facilitating extension agents in Mufindi District

Extension agent	Year started working	Year of termination
Foresters and Agricultural field officers	1961	To date
Sao Hill Project Plantation	1972	To date
CONCERN Project	1983	1999
HIMA Project	1990	2002
Meetings	1988	2002
School	1987	2002
Seminar	1999	To date
Parents	1961	To date

Results on Table 5 show villages that were facilitated by CONCERN/HIMA and Government Extension workers in AF dissemination activities processes in Mufindi district. Statistical anlysis on the impact of adoption indicated that there was a significant differences in adoption amongst the two groups of villages (P< 0.007966).

Table 5: Villages facilitated by CONCERN,HIMA, and Government Extension workers in AF extension serviceses in Mufindi district

Facilitator	Villages	Means %
CONCERN/HIMA	Sawala	14.0a
	Ihiwanza	13.0a
	Kisada	12.0a
Govrnment extension workers	Ikongosi	10.0b
	Sao-Hill	8.0b
	Igomaa	8.0b
Total		**65.0**

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

4.2 Agroforestry systems, technologies and woody perennials preferred by the local communities in Mufindi district

4.2.1 Agroforestry systems and technologies

Results on the Agroforestry systems and technologies that were being disseminated and got adopted by the communities in the district are presented in Table 6 their statistical details are provided in Appendices 17―20. It will be noted that with 92%, the

Agrosilvicultural technologies are the ones that have been more widely disseminated and adopted. The Agrosilvopastral system of homegarden technology has been adopted by a very limited part of the people, possibly because the District generally has little tradition in livestock management. It is also indicated that the taungya technology is significantly the most widely adopted (P< 0.000152) followed by Mixed intercropping and Windbreaks technologies for the higher and mid altitude zones, due to the higher forest activities characterising the two zones.

Table 6: The agroforestry systems and technologies that have been disseminated and adopted by the communities in Mufindi District

Agroforestry systems	Agroforestry technologies	Proportional of adopters
Agrosilvoculture	Taungya system	33.0a
	Mixed intercropping	26.0ab
	Windbreaks	17.0bc
	Shifting cultivation	6.0bc
	Contour bands	4.0c
	Alley cropping	3.0c
	Live fences	4.0c
Agrosilvopasture	Homegarden	8.0c
Total		**100**

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

4.2.2 Woody perennials preferred by the smallholder farmers

The results on the woody perennials preferred by the smallholder farmers of Mufindi district are presented in Table 7. It will be noted that, the woody perennials preferences are statistically different (P < 0.01073), the *Eucalyptus and Pines* were the most preferred tree species in the District (i.e. 24.4% and 22.1% respectively) with the former being the most preferred in the higher agro-ecological zone and the latter in the mid agro ecological zone. Among the retained, naturally occurring indigenous ones, *Faidherbia albida* (Mpogoro) ranked the highest. *Prunus persica* (Peaches) were among the most widely planted fruit trees, (Appendices 21—24).

Table 7: The woody perennials most preferred for planting by local farmers in Mufindi District

Common Name	Scientific Name	Percentage
Mtopetope	*Annona senegalensis*	0.8d
Mkomba	*Bauhinia petresiana*	1.5d
Mbadaga	Not found	4.2c
Mnywewa	*Strichnos coculoides*	0.4d
Mpogoro	Acacia albida	5.7bc
Mjohoro	*Senna siamea*	1.9d
Mkaratusi	*Eucalyptus camaldulansis*	24.4a
Mwarobaini	*Azadiratchta indica*	0.1d
Mangoes	*Mangifera indica*	1.2d
Orange	*Citrus sinensis*	2.3d
Guava	*Psidium guajava*	1.5d
Ovacado	*Persea americana*	1.5d
Mnyitaki (mtovo)	*Azanza garckeana*	2.6d
Lemon	*Citrus limon*	1.9d
Mgunga	*Albizia harvey*	1.1d
Mhangu	*Acacia tortolis*	0.4d
Mkomba	*Bauhinia petersiana*	0.4d
Msukanzi	*Acacia polycantha*	0.4d
Lucina	*Leucaena leucocephala*	0.4d
Gereveria	*Grevilles robuster*	4.6c
Mvanga	*Pericopsis angolensis*	0.4d
Mninga	*Pterocarpus angolensis*	0.8d
Mkulo	*Ocotea usambaranses*	0.8d
Mpululu	*Terminalia sercea*	1.9d
Mbuyu	*Adansonia digitata*	1.1d
Pine	*Pinus patula*	22.1a
Black wattle	*Acacia mearnsii*	7.2b
Peaches	*Prunus persica*	6.1bc
Mhangu	*Acacia tortolis*	0.8d
Mforosadi	*Morus alba*	0.8d
	Total	**100.0**

The Means in the same row that are followed by the same letter do not differ significantly ($P > 0.05$)

4.2.3 Woody perennials preferred for different uses by the smallholder farmers

Results on the woody perennials preferred for different uses are presented in Table 8 and the associated statistical analysis values in Appendices 21— 24 and 31. It will be noted that, the woody perennial uses were statistically different (P <0.000108), uses for timber, fuel wood and construction poles ranked the highest in Mufindi District while uses for animal feed and medicines ranked least.

Table 8: Woody perennials uses in Mufindi District

Wood perennial uses	Adjusted means
Timber	26.33a
Fuel wood	21.27ab
Constructions	20.42bc
Soil Conservation	16.07bc
Shade	7.52bc
Animal Feed	5.7c
Medicine	2.85c
Total	**100.0**

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

4.3 Factors influencing dissemination and adoption of agroforestry

Results on Table 9 and the associated statistical analysis values in Appendices 25—28 show factors influencing adoption in AFTs in Mufindi District. It will be noted that the main limiting factors to farmers' adoption of AFS and AFTs are lack of seeds and seedlings, land shortage and lack of knowledge, which together account for over 72% and drought was least mentioned. Statistical analysis on factors hindering adoption indicated that there were significant differences (P<0.000137) amongst the factors hindering AFTs adoption.

Table 9: Factors limiting dissemination and adoption in AF and AFTs to communities in Mufindi District

Constraints	**Means %**
Lack of seeds/seedlings	36a
Land shortage	24ab
Lack of extension workers	12bc
HIV/AIDS	9c
Fire incidences	8c
Capital	5c
Drought	3c
Animal/ diseases	2c
Total	**100**

The Means in the same row that are followed by the same letter do not differ significantly

($P > 0.05$)

4.4 The corrective measures required for improving adoption

Results on the corrective measures required for improving adoption of AF and AFTs in Mufindi District are presented in Table 10 and details in Appendices 29 and 30. It will be noted that the majority of the farmers (94%) feel that increased AFS and AFTs promotion is the single most significant corrective measure required probably because AF is still a new field of science and widely unknown to many people. The other measures included the use of soil fertility improving woody perennials followed by use of proper component arrangements.

Table 10: The corrective measures required for improving farmers' AFS and AFTs adoption in Mufindi District

Farmers views	**Percent**
Need increased AF promotion efforts	94a
Provision of seeds and seedlings	2bc
Use of proper AF components arrangement	2bc
Selection of soil fertility improving species	2bc
Total	**100**

The Means in the same row that are followed by the same letter do not differ significantly

($P > 0.05$)

CHAPTER FIVE

5.0 DISCUSSION

5.1 The status of dissemination and adoption of agroforestry in Mufindi district

The results on the status of dissemination and adoption of AFTs in Mufindi District and the trend of adoption over time are presented in Tables 1 to 5 with their data and stastical details in Appendices 4 —16.

It was indicated that most of the farmers (65 %) practiced Agroforestry. Although slightly higher, these results compare well with those reported for other areas of this country, such as Shinyanga and the Lake Zone regions that were reported to be 62 and 63% respectively (NASCO, 2004). They are, however, comparatively lower than those of 71% reported for Eastern Zambia in Southern Africa (Keil, 2001) and those of 84% reported for South Benin in West Africa (Honlonkou and Manyong, 1999; Manyong *et al.*, 1999).

Although the experience in Bangladesh and Phillipine has indicated that AFS and its various AFTs were preferentially more adopted in the steeply slopping farmlands or hill sides than in the flatlandand (Salam *et al.,* 2000; Sood and Mitchel 2004; Cramb and Calasero, 2005), on the overall African scale, this phenomenon indicates that Tanzania, and perhaps the whole of East Africa, lacks behind in AF adoption. Because, as shown by a wide variation in the within and between zones conditions, neither the edaphic nor the climatic environmental factors are a reason for the lower AF adoption performance in Tanzania and, therefore, calls for more re-enforced efforts in promoting the adoption of the system and its technologies bearing in mind that it is the only rational way of resource management for ensuring sustainable resource base and the very survival of humanity.

Over most of the initial 30 years, the trend of AF adoption increase was very gradual, reaching a total adoption of only 24% by 1990. It thereafter, however, accelerated to reach the current rate of 65% adoption within the latter 16 years (i.e. an increase of 63% during 1/3 of the period). A rapid upsurge in the AF and AFTs uptake in the latter periods was a combined result of the intensive sensitization, campaigns and support from both the governmental and non governmental organizations especially the Forest Division in the MNRT, CONCERN, HIMA and Sao-Hill Project (HIMA, 2000; Sosovelle and Ngwale, 2002) and an incentive from realized benefits.

5.2 Agroforestry systems, technologies and woody perennials preferred by the small holder farmers Mufidi Ditrict

The results on the Agroforestry systems, technologies and woody perennials prefeered by the local communities in Mufindi District are presented in Tables 6, 7 and 8 with their data and stastical details in Appendices 17―24 and 31. These results show that only two AFS, Agrosilviculture and Agrosilvipasture were implemented in Mufindi district and accounted for 92% and 8% respectively. The higher adoption of the former system is because agricultural crop production is the major socio-economic activity of the communities in the district (URT, 1997) and, therefore, causing it to be the most promoted in the area. The need for the promotion in enabling new innovations to be taken up by the intended farmers agrees well with the findings of (Magcale-Macadong *et al*., 2005) in South East Asia, Adejobi *et al*. (2004) from Ghana in West Africa and Ssemwanga *et al.* (2004) from Uganda, who reported that basic information was required for the users to adopt a new innovation and increased promotion and support by government and various NGOs was necessary to speed up the process. The lower level of Agrosilvopastoral system's adoption in the area, mainly results from the limited tradition in animal production by the local communities in the district (Mdoe and Mvena, 1995; URT, 1997).

Similarly, the domination of the Taungya technology, mainly composed of the exotic woody perennial species, especially in the higher and mid altitude ecological zones, as being a reflection of the high dependence of the involved people on the agricultural and forest based supplies for their livelihood sustenance is, to a large extent, in conformity with the findings reported variously elsewhere (Scherr and Miller, 1991; Ellis, 1993; Ajayi *et al*., 2003). The continuely escalating human populations, dwindling forest estates and deteliorating environmental conditions, however, will in the future require increased promotion of some of the technologies with currently limited utility such as Alley cropping/Hedgerow intercropping, Contour bands, Homegarden, Live fences, Windbreaks and other valuable technologies. While, currently, the Taungya technology produces the most valuable timber and major staple food crops such as maize and wheat, tha Mixed intercropping, which is the leading technology in the lower agro-ecological zone and comprises mainly of retained, naturally occurring woody perennials in agricultural fields, is reported to have high potential in maintaining soil fertility with high quality fodder and hence preferred by farmers (URT, 1997). It has been observed in Kordafan and Darfur, Southwestern Sudan, that a general preference across technologies and much of it is influenced by what farmers see as incentive or dicentive (Rahim *et al.*, 2005). The biggest incentive is the income that is obtained from the sale of the products, increased yields, reduction in hunger periods, the medicinal value derived from such a technology and the general improvement of welfare due to raised farm income (Nyadzi *et al.*, 2003; Simons and Leakey, 2004; Ajayi, 2006). However, such impacts also depend on the circumstances under which AFTs are adopted.

The higher preferences for *Eucalyptus sp* and Pines (*Pinus patula)* by the Mufindi communities were attributed to fast growth, production of good quality timber, vigorous growth even in poor soils, capacity to sprout or coppice (i.e. *Eucalyptus*) when subjected to cutting or burning and production of a diverse of marketable products including poles, firewood, timber, are in congruity with the observations made in Zambia (Mafongoya *et al.,* 2005; Ajayi, 2006). Mpogoro (*Faidherbia albida)* was reported to be the most favoured retained of the naturally occurring woody perennials from the lower agro-ecological zone for reasons of its potential to enrich the soil, usefulness of its pods as good animal feed, provision of shade and seeds that are fire resistant and self propagating. Leakey and Simons (1997); Lulandala (1998); Valdivia *et al.* (2003); Mafongoya *et al.* (2005), and Tilman *et al.* (2005) observed that farmers preferences for specific woody perennials were mainly based on the quantities of biomass produced which determine the effectiveness to fulfil their different requirements. Biomass production is, also, a good proxy for carbon sequestration, pollution filtration and other valued ecosystem services. FAO (2003); Izac (2003); Mbwambo (2004) on the other hand, observed that woody perennials preffered for arid and semi-arid lands of Tanzania included *Pterocurp*s *angolensis, Strichnos coccalodes, Vitex mombassae* and *Faidherbia albida* for mixed intercropping, *Euphorbia tirucali*, *Senna siamea* and *Azadrachta indica* for Windbreaks, *Acacia polyacantha and Senna siamea* for rotation Woodlots, *Sesbania sesban* and *Gliriciduin sepium* for Improved fallows, *Leucaena lucecophala, Acacia angustissima* and *Gliricidiua sepium* for fodder production.

5.3 Factors influencing dissemination and adoption

The results in Table 9 with details in Appendices 16 and 25―28 show that the development of AFS and AFTs in Mufindi District was stalled by inadequate supply of woody perennials germplasm (i.e. seeds, seedlings and other propagation materials), the shortage of land, and lack of extension worker.

The results on the inadequate supply of the programmes' germplasm (i.e. seeds, seedling and other propagation materials) in the Mufindi District are well supported by the observations by (Kilahama, 1994; Butuyuyu, 2003; NASCO, 2004) have indicated that currently the capacity of the Government to run centralized tree nurseries and seed centres is limited and cannot meet the national demand of tree germplasm in a sustainable manner. Even most of the few surviving central nurseries today in various parts of the country, have very low seedling outputs and are unable to meet demands of the surrounding farmers (Aalbaek, 2001 and Kiwale, 2002). These shortages often disappoint farmers who are eventually forced to depend on relatively ineffective private sector institutions that exist, unlike the long well established crop seeds private sector organizations which have been actively engaged in the multiplication and distribution of crop seeds (Aalbaek, 2001; Böhringer *et al*., 2003). Furthermore, Russel (2004) showed that farmers must be persuaded and provided with the necessary skills to establish and manage their own nurseries and ensure that desirable seeds are accessible to them, with emphasize on developing and applying better methods of forecasting seeds needs. Sood and Mitchell (2004) observed that the awareness and knowledge about reliable sources of good seeds and other tree plants inputs play a big role in enhancing AF and AFTs adoption.

Key informants reported that the size of the farmland influences dissemination and adoption of AFTs. This suggests that households with small farm plots of land were more likely to adopt AFS and AFTs than households with large land holdings. These findings are in agreement with the observations made by Kessy and O'kting'ati (1994) thus confirming the suggestion that among other factors decreased farm sizes, increases the rate of AF adoption. AF enables sustainable land use systems which involve intimate and interacting associations between woody perennials, herbaceous crops and or animals/fodder, enhacing productivity involving multiplicity of outputs per unity area at the same time decreasing costs of inputs and sustainability attained, which implies the conservation, AF is responsible for addressing both land and labour constraints facing the majority of the smallholder farmers in rural areas (Ajayi *et al.,* 2007). Other factors that influence adoption of AF include , access to credit ,and risk bearing capacity. However, these factors differ spatially and temporarily (Place and Swallow, 2000).

This observation is also supported by the findings of Hayami and Ruttan (1985) that farmers have ability to cope with reduced availability of resource that change over time by adopting technologies that are more suited to their changing resource endowments. These observations, however, conflict widely with the recommendation by Pattanayak (2003) that due to the economies of scale a farmer with large landholding is more able and/or willing to experiment new AFTs technologies. Perhaps, the key issue is that the plot size may be acting as a proxy for assets or wealth (Cramb, 2005a; Barret *et al*., 2006).

However, smallholder farmers are among those that mostly affected by these factors, have limited capacity to cope with their effects. Their ability to mobilize and manage assets in this case, land is fundamental to their resilience in the face of these challenges (Zbinden and Lee, 2004). There is a growing urgency to understand and address the threats posed by changes in land use and to reinforce the capacity of individuals and communities to withstand or recover from negative effects and to exploit the opportunities that may be available to them (Cramb, 2005b).

Improved land access for the smallholder farmers can result directly in improved AFTs, livelihoods and essential tool to poverty reduction, contributing to increased household food security. Generally, economic growth tends to be higher and more broadly shared when people have equitable and secure access to land (Peterson and Pritchard, 2002). Secure land access and property rights provide important buffers that protect vulnerable groups against deepening poverty particularly when competition for access to resources and efficiency-enhancing land use change are the main drivers of the AFT development process (Ajayi *et al.*, 2007). Secure tenure is also a key prerequisite for promoting medium and long-term investments in land to improve its overall productivity of the smallholder farmers in Mufindi district.

Apart from lack of land and seedlings, lack of extension education services was observed to hinder adoption rate of AF and AFTS in Mufindi district AF extension services in Mufindi are virtually moribund although there are very few NGOs and CBOs dealing promotion and facilitation of innovation amongst smallholder farmers. This could have resulted from the fact that 60% of the extension service personnel had been laid off during the National Civil Services Reform Programme in the late 1990s (DALDO, 2006), Extension worker to farmer ratio has widened and extension services have become less accessible, especially to the resource-poor smallholder farmers, thus, severely affecting dissemination of AFTs and other developmental activities. Previously villages were saved by atleast one extension worker, currently, three to four wards are served by one extension worker (DALDO, 2006). This could partly explain poor delivery of extension services in terms of follow-up mechanisms in the district. Similarly, Ssemwanga *et al.(* 2004); Keil, (2005); Roshetko *et al*. (2006), reporting from Uganda, Zambia and the Phillipines, respectively indicated that effectiveness of AFTs dissemination depended on the presence of adequate numbers of extension workers in the community and/or individual groups who are able to identify extension needs and requests of services and access to information on the AF technological options to smallholder farmers. Ghadium and Pannel (1999); Doss and Morris (2001) observed that the uptake of new technologies was often influenced by the farmers' contact with extension services and level of education of involved farmers. Extension shades light to the reality of life,and create condusive environment through which AFTs could increase productivity and making sure that appropriate technologies for farmers use in a given locality are given, developed and disseminated. i.e. more educated people are more likely to plant more trees (Kajembe and Luoga 1996; Wambugu *et al*., 2006). Furthermore, Place *et al*. (2005) stresses that extensionists are able to enhance the efficacy with which innovations are communicated, thereby reducing the perceived complexity, and enhancing their observability and adaptablity. Extensionists are most effective agents to identify innovators and their innovations (Reed, 2007), previous performance results on AFTs dissemination processes by CONCERN and HIMA show that villages saved by these organization were notably highier adoption than those villages that did not receive innovation services. This suggests that increased extension workers in Mufindi will tend to increase peoples awareness on the importance of AFTs for sustainable development (Kajembe and Luoga, 1996). An increased innovation extension influences the willingness of the local people to participate in AF activities.

The observation of Human Immunology Virus and Acquired immunity Deficiency Syndrome (HIV /AIDS) being a significant factor that influences AF and AFTs adoption in the study area agrees well with the observation of Ajayi *et al*. (2005) in Zambia who further ascerted that the scorge was virtually among the biggest obstacles to sustainable development of many economies. Rural communities are further over burdened as urban patients return to rural areas when the disease seriously takes hold on them (Binswanger, 2000; Hounsome, 2007). However, AFTs continue to offer nutrition benefits, empowerment of community and development of entrepreneurship at community level, reduced labour enterprises as well as scope for growing their own medicine since many HIV/AIDS related conditions are treatable by medicinal trees, including Sexual transimitted Diseases (STD) and skin infections (Binswanger, 2000; Jama *et al.*, 2003).

5.4 Measures required for improving adoption

The results on the measures required for improving adoption of AFTs in Mufindi District are presented in Table 10 and statistical analysis in Appendices 29 and 30. Measures that were suggested by farmers in order to improve adoption of AFTs included provision of more knowledge, good quality germplasm i.e. seeds and or seedlings, use of proper AF components arrangements and selection of soil improving species.

Provision of more knowledge will be through training smallholders through various ways including farmer to farmers groups, farmers exchange vists and tours on farm and on station demonstration centres through radio, electronic devises, individual contacts with farmers and field excussions that have been repeated mentioned by scientists as essential tool for dissemination the programme to be successful done (Ssemwaga *et al*., 2004; Roshetko *et al*., 2006 ; URT, 2006). Furthermore, development of extension services must be based on and take into account the socio-economic status of the farmer, biophysical aspects of the technology and more importantily on the needs of the farmers in the area where the AFTs is introduced. Smallholder farmers must be involved in setting AFTs research agenda and in developing new AFTs, farmers involvement will be essential in providing valuable feedback to research, policy makers and development of practitioners (Thangata and Alavalapati, 2003)

The use of proper AF components arrangement and other management protocols are necessary in order to avoid negative components effects like competition for resources like light, water, and nutrients. Proper components can be supplemented with other management techniques such as pruning, looping, planting of trees on furrows, crops on ridges, pollarding where necessary (Nair, 1993; Chirwa, 2006).

Selection of soil improving species include those woody perennial species that are capable of releasing large nutrients which when they decay or ability of fixing large amounts nitrogen in the soil, resulting into the increased systems productivity (van Noordwijk *et al.,* 2004; Ayayi *et al.,* 2007). Among the woody perennial species with high capacity to improve the amount of soil nitrogen include *Gricidium sepum, Sesbania sesban* (Young, 1997; Chirwa *et al*., 2004). Furthermore, (Honlonkou, 2004; Thangata *et al*., 2005; Chirwa *et al*., 2007) found that short duration rotations of managed fallows found in Benin, Malawi, Zimbabwe, and Zambia, made use of fast growing, nitrogen fixing woody perennial species such as Sesbania *sesban* (*Sesbania*), *Tephrosia vogelii* (*Tephrosia*), *Gliricidia sepium (Gricidia)* and *Cajanus cajan* (pigeon pea)(Ayayi *et al*., 2007). These nitrogen-fixing species have the biological potential to replenish soil fertility and thereby increase crop yields of subsequent crops. Similary, the improved fallow technology has been introduced to smallholder farmers in Malawi, Zambia, and Zimbabwe as a viable alternative to chemical fertilizer use, by using *Sesbania* and *Tephrosia* woody perennial species (Koech, 2005). However, each has its own planting and maintainance requirements and soil improving qualities where it performs better (Chirwa *et al.,* 2004).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on results and preceeding discussion, the following conclusions have been drawn:

(i) AF dissemination in Mufindi District started in the 1960s and its adoption increased gradually while picking up during the last 15 years due to increased community awareness and apparently shown systems' benefits. Todate, 65% of all the Mufindi District's communities have adopted AF and some of its technologies (Taungya, Mixed intercropping and wind breaks). Since about five decades have passed it is concluded that the rate of adoption of AFTs in the district is low.

(ii) Besides the government, NGO's and various other institutions being involved in spearheading the AF and AFTs. It is concluded that there was no close colabration between or among the agents of the dissemination process.

(iii) The AFTs variously adopted by the communities in the district include mainly the Taungya, Mixed intercropping and Windbreaks – all being of the Agrosilvicultural system. Homegarden was the only technology of the Agrosilvopastoral system.

(iv) *Eucalyptus* and *Pine sp* were the most preferred woody perennials especially in the high and mid ecological zones of the district. *Faidherbia albida,* however, was the most preferred in the low altitude zones.

(v) Inadequate supply of tree quality germplasm (seeds and seedlings) and propagation materials, land shortage and poor tenurial systems, lack of extension education and HIV/AIDS were amongst the leading factors limiting dissemination and adoption of AF and AFTs in Mufindi District.

(vi) It been revealed that there is a weak policy framework; some policies have implications on AF development, with the conflicting sectorial interests and mandates which leads to the competing interests eg cash crops versus food crops.

6.2 Recommendations

Based on the data obtained subsequent discussion and conclusions, the following recommendations are given:

(i) Despite the fact that AFS and AFTs being used by a number of smallholder households and having an impact on yields as benefits, its impact at household level is still modest. However, the current status of AFS and AFTs is not well defined. More research is, therefore, required to establish the actual status.

(ii) Land shortage amongst the smallholder farmers can be overcome by developing intensive agroforestry systems. Furthermore, Policies regarding land tenure and property rights among other appropriate policies are important issues that should be considered in the scaling up of AFTs among the smallholder farmers in the District.

(iii) Technology dissemination agents (NGOs) have greatly impacted on AF, however, it is necessary that they should have a reasonable time frame bond in order to allow farmers to learn, practice and realize the importance of the technologies delivered to them. There should be a development network of AF practitious eg farmers, NGOs, GOs and private sectors in order to facilitate long term AFTs management plans to enhance benefits from AFTs for the collective good.

(iv) Rural communities should be persuaded and assisted to establish their own tree nurseries including provision with desirable germplasms (ie seeds and seedlings) and ensure that the products are accessible to smallholder farmers.

(v) More extension officers should be employed in order to fill the gaps created during the implementation of the Structural Adjustment Programme (SAP) in the late 1990s.

(vi) There is a need to have a clear government policy framework to support AF among the many interest groups involved in AFTs. Research and development programmes should be linked to smaholder farmers.

(vii) Farmers should be persuaded to form strong farmers organizations that will offer them opportunity for greater efficiency, effectiveness, equity of provision and access to AFTs . These organizations would also be vehicles through which farmers can pay some contribution for AF services and become actively involved in the planning and management of extension, and act as a voice for their members, in getting services which meet their needs .

(viii) A supportive land tenure and policy conditions must be developed which require broad-based negotiations that involve the participation from the local, regional and national governments as well as the private sector and community based organizations in enhancing AF development.

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APPENDICES

Appendix 1: Household questionnaire

Social-economic factors influencing adopting of agroforestry practice by farmers in three agro-ecological zones, Mufindi district, Tanzania

A: General information

A1. Date of interview…………………………………..

A2. Name of enumerator………………………………

A3. Name of Division………………………………….

A 4. Name of Village ………………………………….

A 5. Identification number of household ……………..

B: Background information

B.1 Sex of respondent:

a) Male [ ]
b) Female [ ]

B.2 Age of respondents in years (If possible estimate the age group).

a) 20-35 [ ]
b) 36-51 [ ]
c) 52-67 [ ]
d) above 67 [ ]

B.3 Marital status of respondent

a) Married [ ]
b) Not married [ ]

B.4 what is your education level?

a) Informal education [ ]
b) Primary education [ ]
c) Secondary education [ ]

B.5 How many people are available for farm work in your household including yourself?

a) <2 [ ]

b) 3-5 [ ]

c) 6-8 [ ]

d) >8 [ ]

B. 6 Do you experience farm labor shortage in you household?

a) Yes [ ]

b) No [ ]

B. 7 What other activities are you having than crop farming?

……………………………………………………………

B. 8 If you are keeping livestock, what is the number ?....................

B.9 How is land owned in you village?

a) Private [ ]

b) Communal [ ]

c) Other specify……………………………………

B.10 Who makes most of the decision on land use in this household?

a) Male [ ]

b) Female [ ]

c) Both male and female [ ]

B.11 Who makes decision on tree planting activities in this household?

a) Husband (Male) [ ]

b) Wife (women) [ ]

c) Husband, wife and children [ ]

B.12 How many farm plots do you have?

a) Not more than two [ ]

b) 3-5 plots [ ]

c) More than 5 plots [ ]

B. 13 What is the field setting of your plots?

a) Consolidated in single block [ ]
b) Separated [ ]

B14 What is the estimated total area (in acres) of your entire farm plots?

a) Not more than two [ ]
b) 3-8 [ ]
c) More than eight [ ]

B.15 What proportion of the total land area is cultivated every season?

a) Only portion of the land [ ]
b) Entire land [ ]

B.16 How did you acquire the land for the plots above?

a) Given by village leaders [ ]
b) Bought [ ]
c) Inherited from family members [ ]
d) Hiring basis [ ]

B.17 What is the topography of your farm plots?

a) On flat land [ ]
b) On slope land [ ]
c) On the valley bottoms [ ]

B.18 Which are most types of crops grown in your fields?……………………….

B. 19 Do you get extra farm produce to take to the market?

a) Yes [ ]
b) No [ ]

B. 20 What is your monthly income (in Tshs '000)?

a) Less than 10 [ ]
b) 10-30 [ ]
c) 31-50 [ ]
d) >50 [ ]

C. Innovation characteristics

C.1 C.4 Do you have trees/shrubs planted in your fields?

a) Yes [ ]

b) No [ ]

C.2 Have you got any advice on tree/shrub planting in field crops?

a) Yes [ ]

b) No [ ]

C.3 If yes, when did you first get advice on tree plating? ………………………..

C.4 Where did you get the idea of mixing trees and crops?

a) From village extension agent [ ]

b) From the village assembly meetings [ ]

c) From other farmers [ ]

d) Other specify…………………………………………

C.5 If yes, Mention number and type of trees of shrubs planted………………….

C.6 Do you get any tree/shrub seeds provided by the project?

a) Yes [ ]

b) No [ ]

C. 7 If yes, what are the tree/shrub seed species provided by the project for planting in your field? ……………………………………………..

C.8 What tree/shrub species would you prefer to plant in your farm and what are reasons for your preference? …………………………………

C.9 What practice do you use to grow trees in your field?

a) As woodlot [ ]

b) In crop field [ ]

c) In field boundary [ ]

d) Around homesteads [ ]

e) Others specify………………………………………

C. 10 What is the species, number of trees/shrubs planted and crops grown in the practice? ……………………………………………………….

C. 11 What is views on agroforestry practice in this area? …………………….

C. 12 What is your recommendations to improve agroforestry practice in this area? ………………… …………………….

D.1 is there any extension officer serving your village/area?

a) Yes [ ]
b) No [ ]

D.2 If yes, how often does he/she visit you?

a) Rarely [ ]
b) Very often [ ]
c) Most during growing season [ ]

D.3. Has He/she ever advised you on agro forestry practices?

a) Yes [ ]
b) No [ ]

D.4 Were the advice given by the extension worker understood?

a) Yes [ ]
b) No [ ]

D.5 is there any organization providing agroforestry extension service?

a) Yes [ ]
b) No [ ]

D.6 Does the village government have any byelaws concerning deforestation?

a) Yes [ ]
b) No [ ]

D.7 If yes, what does it state concerning promotion of agroforestry…

D.8 how do you rate the performance of the bylaws?

a) Effective [ ]

b) Not effective [ ]

D.9 Is there any social-cultural belief on tree planting or forestation in this village?

a) Yes [ ]

b) No [ ]

D.10 If yes, what does it state or advocate…

D.11 How do you rate the performance of traditional rules on promotion of agroforestry

a) Effective [ ]

b) No effective [ ]

Appendix 2:Checklist for district officers/ward/village forest/agriculture extension officer

Factors influencing adoption of agroforestry by farmers in three agro-ecological zones in Mufindi district, Tanzania.

1. What are your views on the current status of the village in terms of agroforestry practices?
2. What are the currently agroforestry extensions approaches used in this area?
3. For how long has the agro forestry practices been promoted in this area?
4. What extension approaches do you think would be appropriate in helping to promote agroforestry in this area?
5. What constraints do you face in implementing agroforestry extension work?
6. What constraints do farmers face in adopting agroforestry technology in this area?
7. What do you recommend do be done for the success of agroforestry practices in this area?
8. What was the target group in the village as far as agroforestry promotion is concerned?

Appendix 3: Checklist for questions for district/village leaders

Factors influencing adoption of agroforestry by farmers in three agro-ecological zones, Mufindi district, Tanzania.

1. Is there any extension worker in your area of governance?
2. What is his/her main activity or activities?
3. Has there been any government involvement in afforestation activities in this village?
4. If yes, what type of involvement?
5. Are there any non-governmental organizations involved in afforestation?
6. Who were the target group in the village as far as agroforestry promotion is concerned?
7. In your view (s) what do you think are the main causes of the current adoption rate of agroforestry practices to farmers in your area?
8. Does the village have any bylaw to protect forests and promote afforestation programmes?
9. If yes, what does it advocate?
10. How do you rate its effectiveness on implementation?
11. Is there any committee in the ward/village government concerned with afforestation?
12. What is your recommendation for the success of agroforestry practices in this area?

THANK YOU VERY MUCH

Appendix 4: Current status of dissemination and adoption of agroforestry technologies in Mufindi District

Farmers who have adopted and not adopted AFTs in the six villages studied

village studied	Farmers			
	Adopter%	Non adopters%	Total	Means
Kisada	12.0	7.0	19.0	9.5a
Sawala	14.0	9.0	23.0	11.5a
Ikongosi	10.0	5.0	15.0	7.5ab
SAO Hill	8.0	7.0	15.0	7.5ab
Ihowanza	13.0	2.0	15.0	7.5ab
Igomaa	8.0	5.0	13 .0	6.5c
Total	65.0	35.0	100.0	50

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 5: ANOVA for adopters and non adopters of agroforestry practices in Mufindi district

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F critical 0.01*
Rows	33.66667	5	6.733333	1.202381	0.422329	5.050329	10.96702
Columns	75	1	75	13.39286	0.014601	6.607891	16.25818
Error	28	5	5.6				
Total	136.6667	11					

Appendix 6: ANOVA for status of Agroforestry adoption in the three agro ecological zones of Mufindi District.

Source of Variation						
Between zones	33.83698	2	16.91849	0.11531	0.891743	3.554557
Within zones	2640.989	18	146.7216			
Total	2674.826	20				

Appendix 7: Agroforestry dissemination and trend of its adoption in six villages studied

	Villages studiedby percent							
YEARS	Kisada	Sawala	Ikongosi	Sao-Hill	Ihowanza	Igomaa	Total	Treatment means
1970	0	0	1.7	1.7	0	0	3.4	0.56a
1980	0	0	2.5	2.5	0	0	5.0	0.83ab
1990	5.0	4.2	5.8	4.2	2.5	2.5	24.2	4.03bc
2000	10.0	10.2	9.3	5.9	8.7	6.8	51.0	8.5bc
2007	12.0	14.2	10.0	8.0	13.0	8.0	65.0	10.84c
Average	2.4	2.8	2.0	1.6	2.6	1.6	13	24.76

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 8: ANOVA for trends of dissemination and adoption of AFTs in villages studied in Mufindi district

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*Fcrit* 0.01
Rows	506.952	4	126.738	50.56979	3.51E-10	2.866081	4.43069
Columns	20.47767	5	4.095533	1.634161	0.196805	2.71089	4.102685
Error	50.124	20	2.5062				
Total	577.5537	29					

Appendix 9: Agroforestry dissemination and trend of its adoption in the various zones of Mufindi District

Year	Ecological zone			Total	Means
	High	Mid	Low		
1970	1.7	1.7	0	3.4	1.1a
1980	2.5	2.5	0	5.0	1.7a
1990	10	9.2	5.0	24.2	8.1ab
2000	19.5	15.9	15.5	51.0	17bc
2007	24.2	20,0	21.0	65.0	22.0bc

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 10:ANOVA for Agroforestry dissemination and trend of its adoption in the various zones of Mufindi District

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit 0.01*
Rows	1013.904	4	253.476	156.757	1.25E-07	3.837853	7.006077
Columns	26.91733	2	13.45867	8.323232	0.0111	4.45897	8.649111
Error	12.936	8	1.617				
Total	1053.757	14					

Appendix 11: Facilitating agents for agroforestry dissemination in Mufindi District

Facilitator	Villages studied by percent							
	kisada	Sawala	Ikongosi	Sao-Hill	Ihowanza	Igomaa	Total	Average
Concern	15	6	3	4	1	5	34	5.7a
Extension workers	0	4	6	4	0	4	18	3.0ab
HIMA	0	2	4	1	3	5	15	2.5ab
Sao-Hill Project	1	4	2	5	0	1	13	2.2ab
Meetings	1	1	1	0	2	2	7	1.2bc
School	2	0	1	1	2	0	6	1.0bc
Seminars	1	1	0	0	1	1	4	0.67c
Parents	0	0	0	1	1	1	3	0.5c

The Means in the same row that are followed by the same letter do not differ significantly ($P > 0.05$)

Appendix 12: ANOVA facilitating organisations responsible with AFTs dissemination in Mufindi District

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit 0.01*
Rows	122.3333	7	17.47619	3.263673	0.008961	2.285235	3.199952
Columns	7.916667	5	1.583333	0.295687	0.912039	2.485143	3.591914
Error	187.4167	35	5.354762				
Total	317.6667	47					

Appendix 13: Facilitating organisations responsible with AFTs dissemination in the three zones of Mufindi District

Facilitating	Agro ecological zones				
	High	Mid	Low	Total	Treatment means
CONCERN	9.0	19.0	6.0	34.0	11.0
Extension workers	10.0	4.0	4.0	18.0	6.0
HIMA	6.0	1.0	8.0	15.0	5.0
Sao-Hill Project	6.0	6.0	1.0	13.0	4.3
Meetings	2.0	1.0	4.0	7.0	2.3
School	1.0	3.0	2.0	6.0	3.0
Seminars	1.0	1.0	2.0	4.0	1.3
Parents	0	1.0	2.0	3.0	1.0
Total	35.0	36.0	29.0	100.0	
Treatment means	4.3	4.5	3.6	12.5	

Appendix 14: ANOVA for Facilitating organisations responsible with AFTs disseminationin thethree zones of Mufindi Dstrict

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit*
Rows	244.6667	7	34.95238	2.96416	0.039678	2.764199	4.277882
Columns	3.583333	2	1.791667	0.151943	0.860434	3.738892	6.514884
Error	165.0833	14	11.79167				
Total	413.3333	23					

Appendix 15: Villages facilitated by CONCERN and HIMA and Government extension agents in AFTs dissemination activities.

Villages facilitated organizations	percentages	Villages facilitated gvt extension agents	percentages	Total	Means
Kisada	12	Ikongosi	10	22	11a
Sawala	14	Sao-Hill	8	22	11a
Ihowanza	13	Igomaa	8	21	10.5ab
Total	**39**		**26**	**65**	**50**

The Means in the same row that followed by the same letter do not differ significantly (P > 0.05)

Appendix 16: ANOVA for villages facilitated by CONCERN / HIMA and government extension agents in AFTs dissemination processes.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	28.16667	1	28.16667	24.14286	0.007966	7.708647
Within Groups	4.666667	4	1.166667			
Total	32.83333	5				

Appendix 17: The agroforestry systems and technologies that have been disseminated and adopted in Mufindi District

Practice	Villages studied						Row total	Treament Means
	Kisada	Sawala	Ikongosi	Sao Hill	Ihowanza	Igomaa		
Taungya system	4.0	10	8.0	7.0	4.0	0	33	5.5a
Mixed intercropping	3.0	3.0	1.0	7.0	8.0	10.4	26	4.6a
Windbbreaks	6.9	2.7	1.3	2.7	2.0	0	16	2.6ab
Homegarden	2.0	2.O	1.3	0	0	2.0	7.6	1.3bc
Shifting cultivation	0.6	0	2.0	1.3	0.6	0.6	6	1.0c
Contour bands	0.6	2.7	0	0	0.6	0	4	0.6c
Alley cropping system	0	0.6	0.6	0.6	0	0.6	2.7	0.5c
Live fences	0	2.0	0.6	1.3	0	0	4.1	0.68c
Column total	18.0	22.4	16.0	14.7	14.7	14	100	16..8
Means	2.25	2.8	2.0	1.8	1.8	1.75	12..5	

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 18: ANOVA for the agroforestry systems and technologies that have be disseminated and adopted in Mufindi District

ANOVA							
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F cit 0.01*
Rows	192.6633	7	27.52333	5.846107	0.000152	2.285235	3.199952
Columns	7.954167	5	1.590833	0.337902	0.886459	2.485143	3.591914
Error	164.7792	35	4.707976				
Total	365.3967	47					

Appendix 19: AFTs disseminated and adopted by the farmers in the three agroecological zone

Agroforestry Technologies	Agroforestry Ecological Zones				
	High ecological zone	Mid ecological zone	Low ecological zone	Total	Means
Agroforestry technologies	Percent	percent	percent	percent	Percent
Taungya	18.0	12.0	3.0	33.0	11.0a
Mixed intercropping	4.0	4.0	18.0	26.0	9.3a
Windbreaks	4.0	10.0	2.0	16.0	5.3a
Homegarden	4.0	2.0	1.0	8.0	2.7ab
Shifting cultivation	2.0	2.0	2.0	6.0	2.0bc
Contour band	3.0	0.0	1.0	4.0	1.3c
Alley cropping system	1.0	2.0	0.0	3.0	1.0c
Live fence	3.0	2.0	0.0	4.0	1.3c
Total	39.0	34	27	100	34

The Means in the same row that are followed by the same letter do not differ significantly ($P > 0.05$)

Appendix 20: ANOVA for distribution of Agroforestry technologies in three zones of Mufindi District

Source of Variation	SS	df	MS	F	P-value	F crit	Remarks
Between zones	2008.096	7	286.8709	4.471047	0.006255	2.657197	Significant
Within zones	1026.59	16	64.1619				
Total	3034.687	23					

Appendix 21: Woody perennials preferences for different uses by the local communities in Mufindi district

Wood perennial uses	Villages studied							
	Kisada	Sawala	Ikongosi	Sao-Hill	Ihowanza	Igomaa	Total	Means
Timber	17.0	12.0	16.0	10.0	12.0	14.0	81.0	14.0a
Fuel wood	6.0	13.0	14.0	8.0	9.0	14.0	64.0	11.0ab
Constructions	9.0	11.0	13.0	6.0	13.0	10.0	62.0	10.0ab
Soil conservations	0	10.0	5.0	13.0	10.0	9.0	47.0	8.0ab
Shade	6.0	0	0	0	8.0	9	23.0	4.06bc
Animal feed	5.0	6.0	0	0	0	6.0	17.0	3.0 c
Medicine	0	0	0	0	0	6.0	6.0	1.0 c
Total	43.40	52.0	48.0	37.0	52.0	68.	300.0	51.0
Treatment	6.2a	7.4a	6.8a	5.2a	7.4a	9.7a		

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 22: ANOVA for woody perennial preferred for different uses by the local communities in the study area

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F cri0.05*	*F crit 0.01*
Rows	784.4762	6	130.746	11.90318	8.25E-07	2.420523	3.473477
Columns	79.14286	5	15.82857	1.44104	0.238423	2.533555	3.699019
Error	329.5238	30	10.98413				
Total	1193.143	41					

Appendix 23: Woody perennials preferences for different uses by the communities in the study area

Uses	Agro ecological zones				
	High	mid	low	total	Treatment Means
Timber	27.0	27.0	26.0	80	26.0a
Fuelwood	27..0	15.0	22.0	64.0	21ab
Constructions	25.0	14	23.0	62.0	20.0ab
Soil conservation	17.0	13.0	19.0	49.0	16.0bc
Shade	0	6.0	17.0	23.0	8.0c
Animal feed	6.0	6.0	6.0	17.0	6.0c
Medicene	0	0	6.0	6.0	2.0d
Total	101.02	79.28	117.46	297.76	72.8

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 24: ANOVA for Woody perennials uses by the local communities in the three agroecological zones in Mufindi District

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit 0.01*
Rows	1533.619	6	255.6032	13.34687	0.000108	2.99612	4.820574
Columns	103.5238	2	51.7619	2.70286	0.107383	3.885294	6.926608
Error	229.8095	12	19.15079				
Total	1866.952	20					

Appendix 25: Factors limiting AF and AFTs adoption by the local communities in Mufindi District

	Villages studied							
Factors influencing adoption	Kisada	Sawala	Ikongosi	SaoHill	Ihowanzaa	Igomaa	Total	Means
Inadequate Seeds	4.0	9.0	6.0	5.0	7.0	5.0	36.0	6.0 a
Lack of land	7.0	8.0	5.0	3.0	1.0	0	24.0	4.0 b
Lack of extension workers	1.0	0	1.0	3.0	5.0	8.0	18	3.0bc
Fire incidences	3.0	4.0	2.0	2.0	0	1.0	12.0	2.0 bc
Capital	2.0	1.0	0	0	0	1.0	5.0	0.6 c
Animals/diseases	1.0	1.0	0	0	0	0	2.0	0.33 c
Droughts	1.0	0	1.0	0	1.0	0	3.0	0.5 c
Total	19.0	23.0	15.0	13.0	14.0	15.0	100.0	16.4
Means	2.7a	3.3a	2.1a	1.9a	2.0a	2.1a	14.2	

The Means in the same row that are followed by the same letter do not differ significantly ($P > 0.05$)

Appendix 26: ANOVA for factors influencing adoption by the local communities in Mufindi district

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit 0.01*
Rows	161.4762	6	26.9127	6.730846	0.000137	2.420523	3.473477
Columns	10.21429	5	2.042857	0.510917	0.765751	2.533555	3.699019
Error	119.9524	30	3.998413				
Total	291.6429	41					

Appendix 27: Factors limiting AF and AFTs adoption by the local communities in the three agro ecological zones of Mufindi district.

Factors influencing adoption	**Agro ecological zones in percentage**				
	High	**Mid**	**Low**	**Total**	**Means**
Lack of seeds/seedlings	15.0	9.0	12.0	36.0	12.0a
Lack of land	13.0	10.0	1.0	24.0	8.0ab
Lack of extension workers	6.0	5.0	1.0	12.0	4.0ab
Fire incidences	1.0	2.0	7.0	9.0	3.0bc
HIV/AIDS	0	2.0	6.0	8.0	2.67bc
Capital	1.0	2.0	2.0	5.0	1.7c
Drought	1.0	1.0	1.0	3.0	1.0c
Animal/ diseases	1.0	1.0	0	2.0	0.67c
Total	38.0	32.0	29.0	100.0	33.3
Average	4.75	4.0	3.6	12.5	

The Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 28: ANOVA for Constraints hindering AFTs adoption by the local communities in the three agroecological zones of Mufindi District

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit 0.05*	*F crit 0.01*
Rows	322.6667	7	46.09524	4.410023	0.008814	2.764199	4.277882
Columns	4.333333	2	2.166667	0.207289	0.815235	3.738892	6.514884
Error	146.3333	14	10.45238				
Total	473.3333	23					

Appendix 29: Farmers' views on AFTs for the three ecological zones of Mufindi District

Views	High ecological zone	Mid-ecological zone	Low-ecological zone	Means
Need promotion for more adoption	97.2%	89.1%	96.0%	94.10a
Reduce farm area	2.8%	3.1%	2.4%	2.77% b
Seed and seedling should be available	0.0%	5.9%	0.0%	1.97%b
Deplete soil fertility	0.0%	2.9%	1.6%	1.26%b
Total	100.00%	100.00%	100.0	100.0

Means in the same row that are followed by the same letter do not differ significantly (P > 0.05)

Appendix 30: ANOVA Farmers views on AFTs for the three ecological zones of Mufindi District

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Rows	1.905566	3	0.635189	579.8457	8.87E-08	4.757063
Columns	1.67E-05	2	8.33E-06	0.007607	0.992431	5.143253
Error	0.006573	6	0.001095			
Total	1.912156	11				

Appendix 31: Different woody perennials uses found in Mufindi District

Tree name	Scientific name	Woody perennial uses			
Mkulo	*Ocotea usambaranses*	fw	ne	sd	
Mkomba	*Bauhinia petersiana*	fw	ne	sd	
Mkaratus	*Eucalyptus camaldulensis*	sd	tb	fw	ne
Mbadaga	Not found	af	sh	fw	
Mnyowa	*Strichnos coculoides*	fd	ne		
Mjohoro	*Senna siamea*	md	fw		
Mwarobaini	*Azadiratchta indica*	sd	af	md	
Mango	*Mangifera indica*	fd	ne	sd	
Orange	*Citrus sinensis*	fd	fw	ne	
Guava	*Psidium guajava*	fd	ne	sd	
Avacardo	*Persea americana*	fd	ne	sd	
Mnyitaki	*Azanza garckeana*	ne	sd	af	
Mpogoro	*Acacia albida*	ne	sd	af	fw
Mtewele	*Brachystegia speciformis*	ne	fw	tb	
15 Mninga	*Pterocarpus angolensis*	ne	sd	tb	
Mtewele	*Julbernadia globilflora*	fw	sd		
Lemon	*Citrus lemon*	fd	sd		
Peaches	*Prunus persica*	fd	fw	ne	
19Pines	*Pinus patula*	tb	ne	po	
Blackwattle	*Acacia mearnsii*	ne	fw	ch	po
Mgunga	*Albizia harvey*	ne	tb	sd	
Grevillea	*Grevillea robuster*	ne	tb	sd	fd
Mtopetope	*Anona senegansis*	fw			
Mduma	Not found	fw	fd		
Mnvasenga	Not found	fw	af		
Mbuyu	*Adansonia digitata*	fw	fd	ne	
Msukanzi	*Acacia polycantha*	fw	ne	sd	
Msindano	*Pinus patula*	fw	ne	tb	
Mtopetope	*Annona senegalensis*	fd	ne	sd	
Mhangu	*Acacia tortolis*	fd	ne	sd	
Mvanga	*Pericopsis angolensis*	tb	fw	ne	

Abbreviations

fd= animal food
fw= fuel wood
ne= nutrient enrichment.
Sd= shade
tb=timber
po=poles