DISSEMINATION STATUS OF AGROFORESTRY TECHNOLOGIES AMONG THE COMMUNITIES: A CASE STUDY OF UYUI DISTRICT TABORA, TANZANIA

BY

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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.

2008

ABSTRACT

The present study was conducted in Uyui District, Tabora Tanzania from November 2006 to January 2007. The aim of the study was to make an assessment on the status of agroforestry dissemination in Uyui District. Specifically, the study assessed the origin and status of agroforestry dissemination in the study area, agroforestry technologies adopted by local communities, benefits gained by the farmers through adoption of agroforestry technologies, constraints to scaling-up agroforestry and possible agroforestry interventions required for programme activity improvement. Data collection methods involved reconnaissance, household interviews, and field surveys. Systematic random sampling was employed to select 20 sample households from selected wards and villages. Data obtained from households were supplemented with the results from the discussions with key informants. Data were analyzed by the SPSS and Excel softwares, ANOVA and LSD tools. The results indicated that, while Agroforestry research started at the ARI-Tumbi in 1987, wider dissemination of the proven useful technologies started during the 2000/01 cropping season, and that by 2006 10% of the Uyui district population had adopted agroforestry. The results further indicated that the ICRAF through SADC/ICRAF Agroforestry project in collaboration with various institutions was the originator of the Agroforestry programmes in the district. About four technologies were disseminated to farmers from which “Improved fallow” and “Woodlots” technologies were found to be the most widely adopted by the local communities in the district while Boundary planting and Fodder bank were less adopted. These technologies have started to provide some of the various benefits to farmers e.g. fuelwood, poles and income. Based on the discussion of these results together with the identified constraints to the effective dissemination of those technologies and determined corrective measures, it is recommended to strengthen extension services, integration of more useful and diversified tree species to increase benefits for the communities from the Agroforestry technologies.

DECLARATION

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

______________________________ ___________________

Candidah Ignatio Kyamani Date

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The above declaration is confirmed

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Prof. Lulandala L.L.L. Date

(Supervisor)

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ACKNOWLEDGMENTS

My deepest appreciation goes to Public Service Management, Gender Unit for financial support for the whole period of this study, I also extend special thanks to my employer, The District Executive Director (DED), Nzega, for releasing me to pursue further studies at Sokoine University of Agriculture. Without such release my studies could have been impossible.

I am indebted to my supervisor Professor L.L.Lulandala from the Department of Forest Biology, Faculty of Forestry and Nature Conservation, for his tireless guidance, constructive criticism and valuable comments during the preparation and write up of this dissertation that have led to successful completion of this study.

I would also like to extend my thanks to the District Administrative Secretary (DAS), Mr. M.J Mabula, Uyui District, for introducing me to the District Executive Director's office which responded positively and provided me with good support. I wish to express my gratitude to all members of staff in Agriculture and Livestock Department and ARI-TUMBI, farmers and village leaders in Uyui District for their co-operation during my data collection.

Thanks also go to the various SUA academic staff and my fellow students for their encouragement and moral support. I am also obliged to mention my appreciations to my family whose moral support and encouragement made it possible for me to accomplish this study.

Special thanks should go to my husband Mr. Michael Japhet for letting me undertake this study and for taking all responsibilities at home and all the hardships he faced during my absence. His prayers and moral support are highly appreciated. To the various other people who are not mentioned here but their contributions had been very helpful, to every one of them I say thank you very much. You have been wonderful and special to me.

Lastly I thank The Almighty God for protecting me and keeping me healthy throughout my studies to this moment.

DEDICATION

This work is dedicated to my beloved parents Mr. and Mrs. Ignatio Kyamani who laid the foundation of my education.

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LIST OF ABBREVIATIONS

AF	Agroforestry
ANOVA	Analysis of Variance
ARI	Agricultural Research Institute
ATTT	Association of Tanzania Tobacco Traders
DALDO	District Agricultural and Livestock Development Officer
DEO	District Extension Officer
Df	Degrees of Freedom
Ha	Hectares
ICRAF	International Centre For Research in Agroforestry
Kg	Kilograms
LSD	Least Significance Difference
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania
MNRT	Ministry of Natural Resources and Tourism
MS	Mean Square
NASCO	National Agroforestry Steering Committee
NFT's	Nitrogen Fixing Trees
SPSS	Statistical Package for Social Sciences
SS	Sum of Squares
TAFORI	Tanzania Forestry Research Institute
Tshs	Tanzanian Shillings
URT	United Republic of Tanzania
VEW	Village Extension Worker
WAC	World Agroforestry Centre

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The major problem in many agricultural based developing countries is environmental degradation which results into soil nutrient depletion hence loss of food production potential (James, 2004; NASCO, 2004). Prolonged low agricultural production leads to low standard of living of rural people. In areas of high population density and small land holdings, agroforestry plays an important role in many farmers' economic strategies. Improved agroforestry techniques help to mitigate the effects of deforestation, land depletion and rural poverty. Understandably, many farmers are concerned principally with meeting household needs using tree products (e.g. fuelwood, building materials and fruits), and only secondarily in potential cash benefits from trees. Using tree products for local consumption has the additional benefit of not having to rely on uncertain market conditions for cash crops. This strategy minimizes risk and contributes to the overall diversification of family farms (ICRAF, 2001a). Agroforestry is a new name, not a new enterprise since it has been practiced under different conditions and in diverse locations for more than a century (Nair, 1989). It is now the one of the most appropriate alternative to the conventional approaches to increase agricultural productivity where farmers choose to grow trees and shrubs with their crops or livestock because they provide additional important benefit they need (Nair, 1989).

According to ICRAF (2000), Agroforestry is defined as a dynamic ecologically based natural resources management option that through integration of trees on farm and in the agricultural landscape diversifies and sustains production for increased social, economic and environmental benefits for the land user at all levels. Agroforestry Research and

Development were initiated in Tanzania in 1986 in collaboration with the ICRAF, following a diagnosis and design survey which was conducted in the country during the early 1980s and identified massive deforestation of natural woodlands due to shifting tobacco cultivation and fuelwood production, thus resulting in serious environmental degradation, decline in soil fertility, crop productivity and shortage of dry season fodder for domestic animals (Oduol *et al*., 2006; Nyadzi, G. personal communication, 2006).

At the onset, various agroforestry technologies were recommended for the trials including screening for appropriate agroforestry trees and shrubs suitable for the area, and tested through on station research at Tumbi in Tabora Region before introducing them widely in the farmers' fields. This was followed by disseminating the identified as suitable agroforestry technologies, by catalyzing their extension and adoption of agroforestry through networking and training of different stakeholders focusing on local communities surrounding the research area (Oduol *et al*., 2006; Nyadzi, G. personal communication, 2006).

1.2 Problem statement and justification

Agroforestry is among practices which are introduced to restore land productivity and improve the ecological and living conditions of the rural families (Limbu, 1999). For about twenty years now, the World Agroforestry Centre (ICRAF), in collaboration with various government and non-government agencies has increasingly been using various approaches in disseminating Agroforestry technologies in Uyui District and other areas of Tabora Region, in order to increase the adoption by the rural communities. It has been reported that farmers now have adopted some of the technologies in their farms with wider diversity of species which provide benefits such as promotion of land productivity, environmental services, soil erosion control, provision of shade, fuelwood, building material and fruits (Ramadhani *et al*., 2002; Oduol *et al*., 2006).

The Government of Tanzania for instance has developed favourable polices and strategies that encourage the adoption of appropriate technologies to alleviate poverty, increase food security and improve environmental management (Limbu, 1999; Oduol *et al*., 2006). For agroforestry to have real impact on rural poverty, food security and environmental conditions, the suitable technologies need to be scaled-up to most farmers and spread widely across the country. Despite these dissemination efforts, no systematic survey to determine the technologies being disseminated and extent of their scaling-up among the communities have been carried out and the underlying information, therefore, remains widely undocumented. It is, therefore the objective of the present study to carry out a systematic survey of Uyui District to determine the status of agroforestry dissemination, the technologies being promoted and adopted, benefits the communities get from their adoption, constraints to their scaling-up and interventions required for improvement.

1.3 Objectives

1.3.1 General objective

Carrying out a systematic assessment of the status of Agroforestry dissemination and adoption in Uyui District, Tabora Region, Tanzania.

1.3.2 Specific objectives

i. To establish the origin and status of agroforestry dissemination in the study area.
ii. To determine the agroforestry technologies adopted by local communities
iii. To determine the benefits gained by farmers through adoption of agroforestry technologies.

iv. To identify the constraints to scaling-up agroforestry and possible agroforestry interventions required for programme activity improvement.

1.4 Research questions

i. What is the origin and dissemination status of agroforestry to communities in Uyui District?

ii. What are technologies widely adopted/preferred by the local communities?

iii. What woody perennial species preferred for use in agroforestry by the local communities?

iv. How do farmers benefit from adopting agroforestry?

v. Do the tree species planted in the field serve the intended purposes?

vi. What are the major constraints to scaling up agroforestry technologies in the district?

vii. What should be done to enhance dissemination of agroforestry practices?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The origin and dissemination status of Agroforestry technologies

2.1.1 The origin of Agroforestry in Tanzania

The World Agroforestry Centre (ICRAF) in collaboration with the Tanzania Government started the first Agroforestry research programme at the Agricultural Research Institute (ARI) at Tumbi Tabora, during the 1986/87 period. The project was part of the ICRAF's collaborative research programme with the African nations for the Southern Africa Development Community (SADC), (Nyadzi, G. personal communication, 2006).

Among the reasons of picking Tabora for the programme were the serious environmental degradation problems that are related to tobacco (*Nicotiana tabacum*) production. The production involves the conversion of large virgin Miombo woodlands for farms at frequent intervals and the produced green leaves need wood for their curing. This had lead to destruction of large areas of Miombo woodlands thereby causing serious environmental problems (Nyadzi, G. personal communication).

The project operated in two phases. Phase I of the project started in 1996 and ended in March 2001. Phase II of the project commenced on April 2001 and ended on 31 March 2006. The goal of phase I was to develop viable and appropriate agroforestry technologies for improvement of soil fertility, provision of fuel wood, fodder, fencing and indigenous fruits. The goal of phase II was to improve living standards of small scale resource poor farmers by increasing agricultural production and conserving environment through scaling-up adoption of agroforestry technologies and innovations among communities (ICRAF, 2001b).

The promising results from the research station, led to the establishment of on-farm trials in the year 1993/94 to assess the potential of the technologies for adoption by farmers. On starting farm trials, farmers from tobacco growing villages were randomly selected. Selection of farmers was done on the basis of their willingness to participate after sensitization meetings in selected villages The trial was researcher-designed and farmer-managed, i.e. type II research trials (Ramadhani *et al*., 2002). According to ICRAF, trials were classified into three main categories including; TYPE I i.e. researcher-designed and researcher managed trials, TYPE II i.e. researcher-designed and farmer managed trials and TYPE III i.e. farmer-designed and farmer managed trials (Mwageni, W. personal communication, 2006).

2.1.2 Experienced approaches and methods for scaling-up Agroforestry technologies

Scaling-up is the sum of all actions, principles and methods that facilitate dissemination of agroforestry innovations leading to their adaptation and adoption resulting in wide spread impact inside and sometimes outside target areas in a given ecosystem (Bunderson *et al.*, 2002). Accelerating impact can be achieved by selecting the most effective (in terms of both cost and time) means of dissemination Makaya (1999), cited by Bunderson *et al.* (2002). On the other hand, Bunderson *et al.* (2002**)** adds that, Agroforestry activities and outputs have to be socially acceptable, environmentally friendly and economically viable and sustainable.

Scaling-up is expected to bring more quality benefits to more people over a wider geographic area (Ajayi *et al*., 2006a; Franzel *et al*., 2006; Oduol *et al.*, 2006). Following the successful demonstration of the potential of Agroforestry technologies to make positive impact on the livelihoods of smallholder farmers, various agroforestry research and development institutions have been focusing efforts in scaling up these technologies to reach a greater number of resource poor smallholder farmers who could potentially benefit from these technologies (Ajayi *et al.*, 2006a). In building farmer capacity and providing them with management and problem solving skills through learning by experience in the field, a mixture of approaches are used to reach farmers and improve their lives through Agroforestry. According to ICRAF (2002**),** scaling-up starts with improved agroforestry technologies developed by farmers and researchers working together. This participatory approach to research is essential for providing different attractive options to farmers since farmers face many different kinds of risks and they naturally seek to diversify sources of income in order to reduce their exposure to such risks. Individual technical options can over time or through widespread use succumb to pest or diseases. There are risks of market failure, as well as those associated with season to season variation in demand and supply, but a variety of tree species and agroforestry options which diversify sources of income buffer farmers against these risks (ICRAF, 2002).

2.1.3 Training of farmer trainers and project partners

This approach involves direct training of farmers as trainers with the ultimate goal being that the farmers trained will in turn provide training in agroforestry fellow farmers in a given locality (Kabwe *et al.,* 2002; Ajayi *et al*., 2006a). Farmers as extension agents have been tried in many developing countries, Scarborough *et al* (1997) reports of such cases in Latin America and Asia where farmer extensionists were used not only in areas where agricultural extension has failed but also where there were no such services. In the case of improved fallows in eastern Zambia, the use of farmer trainers and local leaders as alternatives had been considered for reaching out more numbers of farmers effectively and in a sustainable manner (Kabwe *et al*., 2002). In Kenya, Jama *et al.* (2004) reported that farmer to farmer extension approach was used to facilitate wider adoption of various

Agroforestry technologies promoted to them. It was also pointed out that the major objective of training project partners involved in agroforestry research institutions working at the grassroots level enables them to implement training for farmer trainers in their own project areas (Ajayi *et al*., 2006a).

2.1.4 Farmers to farmers exchange visits

This approach involves exposing farmers to agroforestry by facilitating their visits to farmers in other locations who have been practicing agroforestry for some time and have started to get benefits from adoption of the technologies. As benefits accruing from agroforestry technologies take long, especially the soil fertility improvement options, exposure of farmers to benefits realized by those farmers who have adopted the technologies has proven to be a very effective way of promoting adoption. (Ajayi *et al*., 2006a).The presence of farmer to farmer exchange visits on the tree management shows that if the technology is successful in solving existing problems then some farmers will voluntarily start teaching others. (Bakengesa, 2001).

2.2 Agroforestry technologies adopted by farmers

2.2.1 Agroforestry technologies

An Agroforestry technology is a distinctive arrangement of agroforestry components in space and time (Young, 1989; Gholz, 1987). In Nair (1985) the word agroforestry technology defined as a specific land management operation of agroforestry nature. This means that trees are intentionally used within agricultural systems. Careful selection of species and good management of trees and crops are needed to maximize the production and positive effects of trees and to minimize negative competitive effects on crops (Nair, 1985). Trees in field crops, trees in field boundary, woodlots/rotational woodlots and improved fallow are all considered as Agroforestry technologies. Several Agroforestry technologies aimed at improving soil fertility have been developed tested and disseminated in Southern Africa (Gama *et al.*, 2002). It has been found that, the rate of adoption of an innovation is greatly enhanced when the proposed technology holds potential to solve perceived problems in a particular location (Raintree, 1983). For example Rotational woodlots reported to have several benefits including improving soil fertility, providing fuelwood within three years of establishment (NASCO, 2004).

2.2.1.1 Trees in field crops

According to Kerkhof (1990), trees may intentionally be planted or allowed to persist from natural regeneration in crop fields. A wide range of tree species is often grown with staple food crops in random or systematic spacing depending on the type of tillage equipment used. Decision on spacing is influenced by the tree or crop species and management method chosen. Farmers in semi-arid areas normally leave some trees in the process of clearing crop fields. Trees mainly left have uses including timber, medicine, promoting soil fertility and fruits (Mbwambo, 2004). Operational management for example weeding, pruning and thinning can be done to minimize competition (Nair, 1989).

2.2.1.2 Trees in field boundary

This is the common practice, whereby trees are grown on farm boundaries. The success of this type of technology depends on the observance of the agreement between the neighbors involved to avoid conflict. In small-scale farming areas boundary planting is usually enough to reduce wind speed, and there is no need to establish windbreaks (Nair, 1989). Trees on boundaries that are regularly pollarded can meet most of family’s need for fire wood and other services. Certain species have been traditionally used as boundary markers, including *Croton megalocarpus*, *Cordia abyssinica* and ,*Grevillea robusta*. Trees with short life span like *Acrocarpus fraxinifolius* and *Sesbania* spp are combined with more permanent trees. Also trees that are planted on bunds constructed along contour lines help to stabilize the bunds at the same time producing wood, fertilizing the soil and improving the microclimate (Nair, 1989; Kerkhof, 1990). Apart from the specific use to which these trees are put, they also help in demarcation of the farm field boundaries, serving as security and settling land disputes between neighboring farms (Kerkhof, 1990).

2.2.1.3 Tree planting in Woodlot and Rotational woodlots

Woodlots are small areas of planted softwood or hard wood forest managed for the production of forest products and mostly appears to be established for producing poles and timber rather than fuelwood. These areas are set aside more or less entirely for trees. Vegetables or crops are often intercropped in the woodlots in the early stages of establishment but with time wood production is the most important use (Kerkhof, 1990). The system is spreading rapidly due to shortage of fuel wood and timber in rural areas and cultivated on lands that are usually poor and not suitable for agriculture. Trees are planted very closely usually one meter by one meter and harvested in five to ten years (Ramadhan *et al.,* 2002*).* The negative aspect of this technology is that land, which is normally scarce, is taken out of agricultural production (Kerkhof, 1990).

The Rotational woodlots with some acacia is one of the most promising agroforestry technologies in Southern Africa in increasing land productivity by providing fuelwood, soil fertility replenishment and reforestation in highly degraded lands (ICRAF, 1996). The concept of Rotational Woodlots was developed to evaluate the performance of indigenous and exotic tree species in terms of growth and fuelwood production. Rotational woodlots involve three stages. Tree establishment phase, when trees are planted with crops. Here trees and crops are tended at the same time. This phase can take two to three years depending on tree species, the tree fallow phase when the trees are left to grow and no crop is grown. It has been reported that fast growing tree species yielding 40-90 tons/ha of wood in only 5 years have been identified. These include *Acacia crascarpa* which is very popular in Tabora (ICRAF, 1996; NASCO, 2004). Other species investigated, tested and disseminated to farmers include A. *jurifera, A leptocarpa, Senna siamea, Leucaena leucocephala* and *Acacia polyacantha*.The rotational woodlot technology is reported to have greater potential in rehabilitation of the degraded environments in Tanzania (Mumba *et al*., 2002; Ramadhani *et al.*, 2002).

2.2.1.4 Improved fallow

Improved fallow (IF) is defined as a technology where soils rejuvenating fertility trees/shrubs are planted in land with the aim of improving soil fertility in a short time (Chamshama *et al*., 2006). Temporal arrangements of tree and crop components reduced competition for soil moisture and nutrients making this technology more appropriate to semi arid sites compared to simultaneous agroforestry technologies such as alley cropping (Rocheleau *et al*., 1988). Planting trees to improve fallow periods are applicable in areas where shifting cultivation is practiced. According to Rocheleau *et al*. (1988), Nitrogen Fixing Trees (NFTs) are planted to enhance soil amelioration and reduce fallow periods. Sometimes trees can be purposefully planted in land that is being abandoned, the use of NFTs in this way can lead to quicker rejuvenation of the soil as well as tree products. The benefit of Improved fallow on soil fertility, crop and wood yield improvement depend on the species used, fallow duration and type of annual crops (Buresh and Cooper, 1999). Important genera like *Albizia, Cajanus, Calliandra, Grilicidia, Leucaena, Tephrosia* and *Sesbania* are used to improve fallows. Several studies have demonstrated that improved fallow of 1-2 seasons can increase soil fertility and improve yield considerably (Kwesiga and Coe, 1994; Gama *et al*., 2002; Matata *et al.*, 2006). Farmers trials in Tabora for example, have shown that two year *Sesbania sesban* fallows can double maize yield with no fertilizer. Hence they are being widely promoted to be planted by farmers (Gama *et al*., 2002). It has also been reported that continuous practicing improved fallows can reduce Striga weed incidences (Jama *et al*., 2006). Findings from recent research on effect of *Sesbania sesban* on Striga incidences conducted in Tabora, confirmed reduction of Striga seed population in the soil at the same time improve maize yield (Matata *et al.*, 2006). However, certain species like *Cajanus cajan* and *Sesbania sesban* were reported to transmit pests to cassava crop thus farmers avoided incorporating these species in their fields (James, 2004).

2.2.1.5 Tree species preferences

Performance of tree species in relation to environment and their effects on the soil, the propagation, management requirements and the direct economic and nutritional benefits as well as types of farming systems may lead farmers to mostly preferring some of the species and rejecting others (Eckman and Hines, 1993; Lengkeek, 2003; James, 2004). The strongest preference generally tends to consider wood uses of trees of which the most important include firewood, building materials and domestic items. In a study conducted in Musoma, Tanzania by James (2004), among the tree species promoted, two tree species, *Melia azedarach* and *Cedrella odorata* were identified as drought and pest resistant, fast growing, not browsed by animals and economically valuable trees. On the other hand, *Eucalyptus spp* was reported to highly compete with crops for water and nutrients, hence less preferred by the farmers. In a study conducted in Philippines by Mangaoang and Pasa (2003) revealed that farmers have high preference for ‘premium’ native trees i.e. those with high quality by products and multiplicity of uses, both economically and ecologically. Other exotic tree species which widely preferred and planted almost in all parts of Africa including Tanzania is Gre*villea robusta*. Its preference is due to drought tolerant and deep rooting systems characteristics (i.e. causes little interference with shallow rooted crops), thus it can be successfully intercropped with various agricultural crops (WAC, 2006).

2.3 Benefits gained through practicing various Agroforestry technologies

Agroforestry offers several options that can contribute to food security, improve nutrition, alleviating poverty and sustaining the environment as shown in various literature sources (Zeng, 1999; Ajayi *et al*., 2003; Jama *et al.*, 2004; Ajayi *et al*., 2006a).Various tree species are grown for both productive and protective purpose uses i.e. they serve as sources of fruits for food, fuelwood, fodder, medicine and poles or timber (productive purposes), they also serve for protective purposes such as windbreak, soil erosion and conservation. Other roles include living fences, boundary markers, support trees, and for household implements (Zeng, 1999; Franzel *et al.*, 2001).

2.3.1 Productive benefits

Agroforestry contributes a wide range of goods to rural communities (Rocheleau *et al*., 1988). The benefits played by agroforestry technologies include the production of food, fodder, fuelwood and fruits (Young, 1990; Nair, 1993; Ramadhani *et al*., 2002). In a research conducted in Zambia, Kwesiga et *al*. (2003) showed that fertilizer trees in agroforestry system increased the yield of maize (the staple food crop in Southern Africa) by two or more times compared with the usual smallholder farmers practice of continuous maize cropping without inputs. Thangata and Alavalapati (2003) noted that increase in soil fertility and higher maize yields are possible when Grilicidia (*Gliricidia sepium*) is grown as intercrop with maize. Increased yields of associated crops, reduction in system's production inputs, increased labour efficiency and thus satisfaction of the basic needs such as food, shelter clothing, and medicine, cash income, raw material for crafts, saving and investments and resources for social obligations (Rocheleau *et al*., 1988).

2.3.2 Protective benefits

In addition to increase in food production, Agroforestry also conserves natural resources base and protects the environment (Ajayi *et al*., 2006a). Deforestation is an important economic problem in the developing countries especially in countries where tobacco is grown (Ajayi *et al*., 2006b). However, agroforestry provides an alternative source of firewood for curing tobacco and thus has a greater potential to contribute to the reduction in the deforestation of the Miombo woodlands (Ramadhan *et al*., 2002). According to Ajayi *et al.* (2006b) farmers who established fertilizer tree fallow fields are able to have some of their fuel and wood requirements for their households satisfied from their own fields. This again may reduce the exploitation from communally owned Miombo forests and thus reducing deforestation. The vegetative cover provided by the trees, crops and grasses facilitate the protective role of agroforestry technologies by preventing soil erosion. According to Nair (1989), the protective cover on the soil provided by the vegetation prevents erosion through mulching. Some species used in Agroforestry can be used in pest and disease control**.** For instance, some improved fallow species (e.g. Tephrosia) can control mole rats, the important pest in many farming system. Improved fallows have also been used to provide good control of *Striga hermothica*, a major parasitic weed of maize and other cereal crops in western Kenya (Jama *et al*., 2004).

2.3.3 Social economic benefits

Various sources of literature indicate that rural communities can increase their income by utilizing and marketing tree products from forests and horticultural tree crops grown on farms (Mithofer and Waibel, 2003; Mbwambo, 2004; Akinnifes *et al*., 2006). It has been found that about 24% of the world's population both rural and urban or 1.5 billion people in developing countries of Asia, Africa and Latin America depend largely on Agroforestry products and services for their livelihood ICRAF (1997), cited by James (2004). Rural dependency on Agroforestry is primarily reliance on trees for fuelwood for cooking and fodder for feeding animals. Usage of fruit trees (both indigenous and exotic tree species) in Agroforestry gives the added advantage of provision of fruits both for consumption and cash (Masangano, 1996; Leakey *et al*., 2003; Gonzales-Soberanis and Casas, 2004). It has been also reported that the pilot project conducted in Manyoni District, Tanzania, found that income accrued per individual beekeeper increased from USD $ 150 to USD $ 691 in three years (i.e. 2000-2003) through use of agroforestry. (Mwakatobe and Mlingwa, 2005)

2.4 Constraints in dissemination of Agroforestry technologies and corrective measures required for improvement

2.4.1 Constraints in dissemination of Agroforestry technologies

It is clear that the overall objective of agroforestry is to improve the existing situation through increasing both quantity and quality production, to generate sustainable agricultural products, to reduce environmental damage and improve the living standard of the human population (Rocheleau *et al*., 1988; Nair, 1989). However, there are constraints that limit dissemination and adoption of agroforestry technologies. These constraints are highlighted below.

2.4.1.1 Educational level, knowledge and extension services

According to Mnyenyelwa (2005), education is perceived as being among the factors that influence individual's perception of interventions (e.g. agroforestry technologies) before making a decision to take part. It also imparts a desire of an individual to learn more, attend training and seek information regarding agricultural and non-agricultural activities. On the other hand, Messo (2004) pointed out that literate farmers make good use of contact farmers because they can write, keep records and read information. According to Lapar and Pandey (1999), adoption of soil conservation in Philippine could be hypothesized as positively correlated with the farmers' educational level. Conversely, Kalineza *et al*. (1999) found that education was not a significant determinant of the adoption of soil conservation practices in Tanzania. Empirical evidence (Senkondo *et al*., 1998; Kalineza *et al*., 1999) suggests that farmers who are knowledgeable in a technology are expected to adopt the technique more readily compared with those who are not knowledgeable regardless of their level of education. Also, Yaron *et al*. (1992), adds that innovativeness is influenced by extension, but not necessarily education. This means that farmers with elementary school education are capable of adopting innovation and complex technology if proper extension services are provided. Kalineza *et al*. (1999) insisted that extension and education increased knowledge, thus accumulated knowledge in turn influences adoption of technologies. Extension contact is known to catalyze awareness, organization, and information exchange and technology adoption among farmers. For instance, when conducting a study in Niger, Baidu-Forson (1999) observed that adoption was higher for farmers having contacts with extension agents working on Agroforestry technologies than farmers who had never experienced any extension contacts. In a study conducted in Zambia it was found that many adopters comprised of those who had been formally trained by organizations that support agroforestry, or informal knowledge sharing by fellow farmers who had adopted earlier and through farmer exchange visits (Ajayi *et al*., 2003). Unlike annual crop production technologies conventional soil fertility management options require skills in terms of management of the trees (Ajayi *et al*., 2006a).

2.4.1.2 Provision of germplasm

Successful scaling-up is based on sustainable supply of germplasm of high physiological and genetic quality for wide range of agroforestry species that can meet the demand and priorities of smallholder farmers (Ramadhani *et al*., 2002; Ajayi *et al*., 2006a). A survey that was conducted in southern African countries (Mumba *et al*., 2002; Ajayi *et al.*, 2003; Bohringer *et al*., 2003) identified lack of access to quality seeds constituted the greatest constraints of some to Agroforestry technologies adoption. This leads to the suggestion that, Agroforestry technologies to be widely disseminated to farmers, there should be sustainable supply of agroforestry tree seeds that can meet the needs and priority of small scale farmers.

2.4.1.3 Size of available land and land ownership

Alavalapati *et al*. (1995) showed that possession of land is necessary condition for adoption of Agroforestry technologies. Adesina *et al*. (2000) found that in areas of high population pressure and with small farm sizes, agroforestry trees competed with food crops thereby negatively affecting adoption of alley farming. Farm size is often hypothesized as a determinant of adoption, large farm sizes are able to capture several effects including fixed adoption costs, risk preferences, human capital endowments, credit constraints labour requirements and tenure arrangements (Feder *et al.,* 1985). When studying fertilizer application and tree fallow effect in Zambia, Ajayi *et al.* (2003) found that establishment of fertilizer tree fallow plots were positively associated with the availability of land and size of land holding. Land ownership pattern has been noted to be a fundamental challenge in dissemination and adoption of Agroforestry technologies (MNRT, 2003; Msuya *et al*., 2006).

Observation made by Bakengesa *et al*. (2002) found that, insecurity on land and tree tenure has resulted in low adoption of agroforestry technologies by farmers in Shinyanga, Tanzania. It was also statistically proven that the most significant factor in the adoption of Agroforestry technologies in Musoma, Tanzania was land size (James, 2004). Sometimes the couple may be given land by their parents to use but the control still remains with the parents (Bakengesa, 2001). It has been reported from some areas of Southeast Asia, (Guzman, 1999) that land ownership was not clear thus causing serious conflicts and discouraged the planting of long term species (i.e. tree cash crops or timber species) in these areas. Many farmers would prefer planting short-term crops such as food crops, but they would not grow trees because when the trees finally mature, the more powerful people in the community might claim the right of ownership of trees (Guzman, 1999; Randy *et al*., 2005).

2.4.1.4 Local and national policies

It has been reported that some local customary practices and institutions prevailing in a given region may limit the widespread uptake of some Agroforestry technologies (Ajayi and Kwesiga, 2003). Examples of customary practices include incidences of bushfires and free grazing during the dry season. The animals destroy the trees after planting either by browsing the leaves and removing the biomass or by physically trampling over the plants. In some countries policies affect scaling-up of the technologies. In Zambia for example, the community's institutional regulations for fruit collection, land and tree tenure were found to affect individual farmer's decision to invest in establishing an indigenous fruit tree orchard (Ajayi *et al*., 2006b).

In parts of Kenya, there is a policy which requires farmers to obtain permits before cutting down trees, this discourages farmers to plant trees, since they may not be able to harvest them freely. However, Agroforestry researchers and development staff work to understand and inform decision makers about these constraints to the dissemination of the innovations imposed by prevailing policies (ICRAF, 2002).

2.4.1.5 Other factors limiting dissemination of Agroforestry technologies

Different sources of literature have pointed some constraints to the adoption and dissemination of Agroforestry technologies. Flexibility and compatibility of agroforestry to existing farming systems among others are important factors affecting adoption of agroforestry technologies (Place and Dewees, 1999). Observability is another mechanism through which trials can increase adoption rates. Demonstration plots can improve the observability of agroforestry practices and have shown to have direct impact on agroforestry adoption rates. Three studies conducted by Mumba *et al*. (2002), Ramadhani *et al.* (2002) and Mnyenyelwa (2004) found drought to be one of the major constraints in the establishment and management of agroforestry in some parts of Tanzania. Other factors include birds, pests, diseases, inadequate farming skills, insufficient attention by officials and policy markers on Agroforestry technologies. Access to roads and market, location relative to institutions promoting agroforestry were also mentioned as among factors limiting dissemination and adoption of agroforestry innovations (Mnyenyelwa, 2004).

2.4.2 Corrective measures required for improvement in dissemination of Agroforestry technologies

Different ways have been suggested that should be considered in improving dissemination and adoption of various Agroforestry technologies. Among them include designing appropriate research and extension programs, establishing demonstration plots and seed provision, farmers training, farmer to farmer visits and farmers' participation.

2.4.2.1 Designing appropriate research and extension programs

Research and extension programs need to be designed appropriately if the rate of adoption is to be increased (Baidu-Forson, 1999; Masangano, 1996). Emphasis should be on the relative advantage of the technologies, also recommended technologies must be able to make a big impact on the farmers. It is not possible for farmers to adopt a technology they do not know .Which means, before any accumulation of knowledge and experiences start, farmers must be aware of a new technology in the environment (Oluko *et al*., 2000). The technologies must also be designed in such a manner that they are compatible with farmers' current practices and social norms while providing solutions to their needs, problems and constraints. Research on social issues should look into issues of market availability for agroforestry products, and where necessary possibilities of developing such markets should be investigated (Masangano, 1996), socio-economic conditions under which farmers are operating and how those conditions are likely to impact the adoption of agroforestry technologies and farmer perceptions of agroforestry technologies (Ajayi *et al*., 2006a).

2.4.2.2 Establishing demonstration plots and seed distribution

Demonstration plots are established in strategic locations to serve as learning centres and farmer field schools, also help to provide seeds which are required for scaling up (Kerkhof, 1990; Oduol *et al.*, 2006). Through demonstration plots most farmers can be easily trained, also advantages and disadvantages of practicing Agroforestry technologies, types of Agroforestry technologies, methods and techniques for practicing Agroforestry technologies can be learnt there. Managemental practices which involve monitoring and maintenance of tree nurseries and problems of controlling weeds are demonstrated. Examples of such managemental practices includes, checking for tree survival, replacing trees that die, watering and checking for pests (Ramadhani *et al*., 2002). Other factors reported to be the most important constraints to the greater adoption of agroforestry in some southern African countries include inadequate tree seeds, seedlings and other planting material (Gama *et al*., 2002; Ajayi *et al.*, 2006a). When studying agroforestry adoption in southern Malawi, Thangata and Alavalapati (2003), found that the adoption of mixed intercropping of *Grilicidia sepium* and maize depended on the supportive mechanisms to help farmers in the adoption process such as providing them with free seeds or seedlings. Thus, free seed supply in the initial stages of the project for smallholder farmers is suggested. However on the other side continued free seed supplies make it difficult to determine the effective demand for Agroforestry seeds and undermines the establishment of a sustainable seed supply system (Ajayi *et al*., 2003).

2.4.2.3 Farmers training, farmer to farmer visits and farmers participation

Farmers' training is important strategy for increasing adoption of Agroforestry technologies. According to Masangano (1996) and Mlenge (2004), farmers training not only creates awareness in the target audience but also increases farmers' knowledge and competence and creates a positive attitude on Agroforestry technologies promoted. It has been stressed that exposure of farmers to benefits realized by those farmers who have adopted the technologies has proven to be a very effective way of promoting adoption (Ajayi *et al.*, 2006a). Bakengesa (2001) pointed out that the presence of the farmer to farmer training on the tree management shows that if the technology is successful in solving existing problems then some farmers will voluntarily start teaching others.

The farmer to farmer visits are not only beneficial to the farmers but also to extension staff who learn from them. During these visits that arouse curiosity, enthusiasm and determination, farmers get to learn about various technologies, tree nursery establishment, farm tree conservation, tree management and field tree planting. It is also a very strong communication channel that facilitates sharing of information and internalization of environmental issues. It also stimulates farmers' consciousness and the spirit of togetherness (Mlenge, 2004; Ajayi *et al.*, 2006b; Msuya *et al.*, 2006). Having been involved in both development as well as extension, farmers are likely to understand the technologies better (Masangano, 1996). Various studies that investigated adoption rates of technologies that had been proven successful through research trials were found to have low adoption rates as a result of poor or lack of farmer's participation (Osemeobo, 1990; Adesina and Coulibaly, 1998). Sharing information and knowledge is vital to ensuring effective scaling-up processes. In Zambia, for example Franzel *et al*. (2001), found that higher adoptions of improved fallows were associated with proper and effective diagnosis of farmers' problems, their participation in programmes and encouragement of their innovations. Farmer's knowledge about individual species helps researchers to select which ones to focus on, but even more important are farmer's involvement in experimentation and the sharing of local knowledge among farmers themselves (Wambugu *et al.*, 2001; Gama *et al.*, 2002).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Materials

3.1.1 Description of the study area

3.1.1.1 Location of the study area and population size

Uyui District is among the six districts of Tabora Region. It lies between Latitude 4˚ 5″ and 5˚ 15″ and between Longitudes 32˚ 15″ and 34˚ 15˚ (URT, 2005).

Geographically, Uyui District is located near the centre of the region. It surrounds Tabora town covering an area of 14 340 km^2. The district borders Kahama, Igunga and Nzega Districts in the North and Singida Region in the East. In the south it borders Sikonge District, while in the West borders Urambo District. The district is comprised of 3 divisions namely Uyui, Igalula, and Ilolangulu. There are 17 wards with 93 registered villages (DALDO, 2005).

According to the Tanzania Census of 2002 the population was estimated to be 282 272 people. The dominant indigenous people in this district are Nyamwezi and Sukuma. The significant minority tribe is the Ha and Tutsi (DALDO, 2005; URT, 2005).

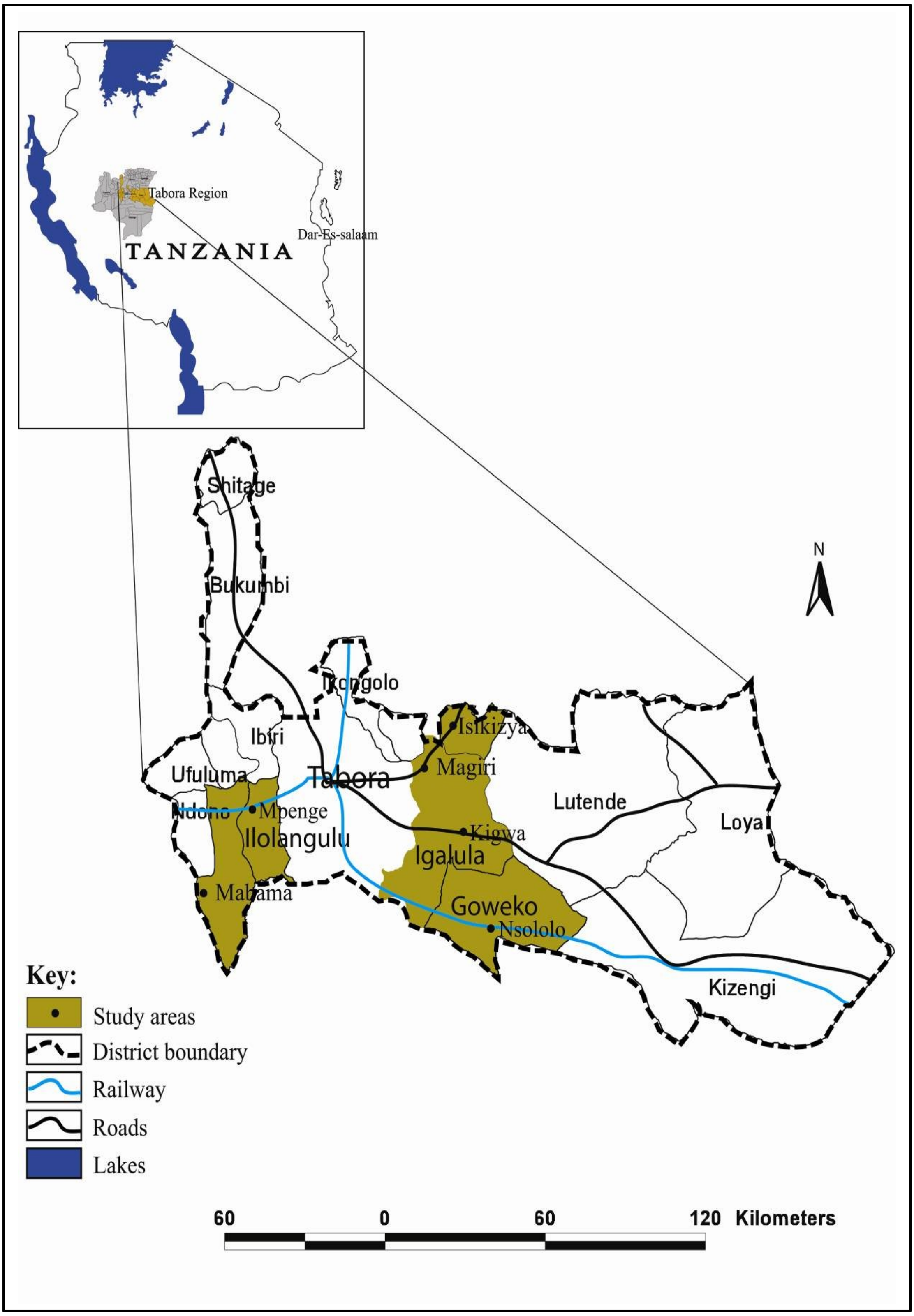

Figure 1: The location of the study areas in Uyui District, Tabora, Tanzania

3.1.1.2 Climate

Uyui District council lies on at an altitude of 1100 ma.s.l (metre above sea level), with temperatures ranging from 28 to 30˚C. Highest temperatures are experienced in October just before the on set of the rain season. The rainfall pattern is unimodal, falling between November and April; its distribution is extremely variable and unpredictable. The annual mean rainfall is usually less than 700mm with a peak in December followed by a slight dry spell in January or February. The rains then tail off in April sometimes extending into May (DALDO, 2005; URT, 2005).

3.1.1.3 Land use, economic activities and infrastructures

Uyui District has a total land area of about 1434 000ha (14 340 km^2) with a potential arable land of about 661 500 hectares and grazing area of about 871 700ha. The main economic activities in the district include agriculture and livestock keeping. Tobacco growing is a wide spread and main economic activity (Almost 65 % of the population cultivate tobacco) although in a small scale farming system (DALDO, 2005). Food crops grown in the district include paddy, maize, sorghum and pulses. Cash crops grown are groundnuts, sunflower, cotton and tobacco. Animals kept with their numbers in bracket include cattle (107 628), goats (42 628), sheep (9835) and pigs (198) (DALDO, 2005; URT, 2005).

Livestock keeping is the second most important economic activity which utilizes the available farming grassland and forests in which also beekeeping activities are practiced. Road network of about 1014 km classified in four classes as follows, trunk roads 37km, regional roads 248 km district roads 498 km feeder roads 236 km but only 20% of the district roads are passable throughout the year. Roads transport facilities are present (e.g. bus stands etc) though not well distributed to cover the whole district (DALDO, 2005).

3.1.1.4 Topography, soils and vegetation, water resources and drainage

Topographically the District is relatively homogeneous with gentle land plains intersected by seasonal flooded valleys. The largest area suitable for cultivation is covered by drained soils that have sandy, clay and loam soil. The large parts of these soils have low nutrients contents and classified as infertile.

Therefore, soils of Uyui District Council can be described at the best as moderately fertile with extensive areas being infertile. The vegetations are mainly of deciduous Miombo woodlands, which occur throughout the southern interior of Africa. Dominant upper storey woody plants include *Brachysteagea* and *Isoberlina* species, which in the drier season Eastern area *Acacia/Cambretum* communities dominate. Hyparrheria dissolute is the dominant grass species (DALDO, 2005; URT, 2005).

3.2 Methods

3.2.1 Sampling procedures

In this exercise, both purposive and systematic random sampling procedures were adopted. Purposive sampling had adopted in order get villages involved in on-farm trials also villages that were involved in the stage of wider dissemination programme. Systematic random sampling allows selection of a sample from the entire population in such a way that every member of the population has an equal chance of being selected Also it made it easier to select respondents from a large geographical area. All the three divisions of the Uyui District were surveyed i.e. Uyui, Igalula and Ilolangulu (Table 1). From each division, two villages were selected; Isikizya and Magiri from Uyui, Kigwa and Nsololo from Igalula while Mpenge and Mabama from Ilolangulu. Accessibility and involvement in either Phase I or Phase II were the criteria considered in selecting study villages. At the time of data collection, there was heavy rainfall and many areas in the study area were flooded hence inaccessible. Magiri, Isikizya and Mpenge were involved in on farm trials. Again systematic random sampling was used to select 20 households from each village for the study (i.e. the households in inaccessible areas were systematically left out followed by random selection of households of the accessible areas). Overall 120 households were used in the present study (i.e. three divisions, each division two wards, each ward one village and each village 20 households).The registers of households available at each village office were used in selecting the sample households.

Table 1: Sampled households in the surveyed Villages

Villages	Total number of households in the village	Number of sampled household
Isikizya	450	20
Magiri	417	20
Kigwa	963	20
Nsololo	611	20
Mpenge	332	20
Mabama	588	20
Total	**3 361**	**120**

In addition to the households, the District Planning Officer, District Extension Officer, Ward and Village Executive Officers, Village Chairpersons, various Ward /Village Extension Officers were consulted for additional information.

3.2.2 Data collection

3.2.2.1 Reconnaissance survey

Reconnaissance survey was carried out in order to make self introduction to the community as a researcher as well as to introduce the aim of the present study. Through this exercise also identification of various people involved in agroforestry activities, leadership, environmental committees, various extension workers, NGO’s operating in the area was made. It is during this time when the researcher was in a position to get important data especially demographic data, including total households in the village, structure and composition of households. Through reconnaissance survey the researcher was able to familiarize with the background of the study area therefore be able to improve data collection procedures.

3.2.2.2 Interviews

Primary data were partly collected through formal survey by interviewing heads of 20 selected households in each village, using household questionnaires. Data collected through this method included background information, farm size and land use, Agroforestry technologies dissemination and adoption, Agroforestry benefits gained through practicing promoted Agroforestry technologies, constraints in dissemination of Agroforestry technologies and respondent’s view on corrective measures required to improve Agroforestry dissemination to the communities (Appendix I). Also checklists of sets of open-ended questions were used as a guide in the collection of information from key informants. Open-ended discussions were made with the District Agriculture and Forestry Officials, Project staff, village leaders, different interest groups e.g. women groups and some of farmers who involved in on-farm trials for more clarifications on issues related to research (Appendix II). The interview was conducted in Kiswahili Language. Secondary information was obtained from various published and unpublished documents and reports on the Region, Districts, wards, villages, Internet and from Libraries.

3.2.2.3 Field survey

The survey was carried out in the study areas to confirm the information obtained during the interviews. Also this survey assisted the researcher to have a general picture on the various Agroforestry technologies adopted and types of tree species planted by farmers, through visiting farmers' fields, importance of each species basing on time or year of planting. Much information can be obtained simply by observing what goes on (Katani, 1998). It is always essential to keep one's eyes when visiting the farm and to check what you are told against what you see (Lema, 2003).

3.3 Data analysis

Data collected from the primary source using structured questionnaires were summarized, coded ready for analysis. Data collected were analyzed by both Statistical Packages for Social Science (SPSS) and Excel computer software. Content analysis was used to analyze the qualitative data in which components of verbal discussion and the qualitative information from the open-ended questions were analyzed using this method. In this way, constraints in dissemination of Agroforestry technologies and respondents' views on corrective measures required in improving agroforestry adoption were broken down into smallest meaningful units of information. Scientific names of common indigenous tree species that retained in the farmers' fields (Appendix V11) were given by the staff from ARI-Tumbi also obtained by consulting a book (Ruffo *et al*., 2002). Data were organized into descriptive statistics such as means, frequencies, and percentages and cross tabulation. The Statistical Package for Social Sciences (SPSS) was the main tool used to obtain frequency distribution and cross tabulation of responses from interviewed sample. Analysis of Variance using Completely Randomized Block Design (CBRD) was used to test the significance of responses from all six villages. Furthermore, the Least Significance Difference (LSD) was used to separate the differing means. The differing means in the contrasts were identified by letters e.g. a, b, c and d (detailed calculations are clearly shown in Appendices IIIa- VIc).

CHAPTER FOUR

4.0 RESULTS

4.1 The origin and dissemination status of Agroforestry in Uyui District

4.1.1 The origin of Agroforestry in Uyui District

The results on the origin and dissemination status of various agroforestry technologies in Uyui District are presented in Table 2 and 3. It will be noted that the ICRAF, in close collaboration with the ARI-Tumbi, was the originator of the Agroforestry programmes in the district, initially as a research activity (i.e. trials for suitable technologies and appropriate woody perennials) and later expanding into a wider dissemination of the confirmed suitable Agroforestry interventions to address various community related resource use issues. The other various collaborating institutions joined the dissemination process at the various periods later.

Table 2: Origin and various institutions that collaborated with ICRAF in disseminating Agroforestry in Uyui District

Institution	Activities (Contribution)	Period	
		Started	End
ICRAF	Initiating research in Agroforestry at Tumbi, Tabora, training of farmers and extension agents	1987	1994
ARI-Tumbi	Conduct research (i.e. screening of tree species and provenances), training of farmers and extension agents, procurement of tree seeds and tree plants	1993	-
ATTT(Tobacco Company)	Provide seedlings to farmers	1999	-
District Agricultural and Livestock Officer(DALDO)	Training farmers through extension services, distribution of seeds	2000	-
Africare	Provide funds to assist training, purchase seeds /seedlings	2002	-

Source: DALDO (2003). Note:The dash sign (-) means ending period of contribution was not indicated

Also to note is the fact that the programme started as on station research, later expanding into on-farm trials on the pilot farmers' fields during the 1993/94 cropping season before, finally, being widely disseminated for adoption in the farmers' fields in the whole district during the 2000/01 cropping seasons.

Table 3: Farmers practicing agroforestry in Uyui District

Technology	Y ears*					
	2001	2002	2003	2004	2005	2006
Rotational woodlot	572	960	964	1 028	1 380	1 395
Improved fallow	251	541	891	910	1 953	2 216
Boundary planting	427	572	572	740	740	768
Fodder Banks	137	154	164	212	628	637
Total	**1 387**	**2 227**	**2 591**	**2 890**	**4 700**	**5 016**

Source: DALDO (2006). * Based on Phase II of the project i.e.wider dissemination programme

Table 4: Farmers adopted various agroforestry technologies in sample villages since the dissemination programme started in 2001

Village	Years*						Total	
	2001	2002	2003	2004	2005	2006	Households in village	Proportion adopters (Percentages)
Isikizya	5	11	11	23	48	57	450	13
Magiri	7	10	18	36	42	49	417	11
Kigwa	10	10	17	52	77	90	963	9
Nsololo	6	9	9	I9	28	32	611	5
Mpenge	9	21	26	40	45	52	332	16
Mabama	3	10	10	17	32	38	588	6
Total	**40**	**71**	**91**	**187**	**272**	**318**	**3 361**	**60**
Average	**7**	**9**	**16**	**31**	**45**	**53**	**560**	**10****

Note: * Based on Phase II of the project i.e. wider dissemination programme

** taken as average for the whole district.

4.1.2 Strategies for dissemination of Agroforestry

The results on the strategies for dissemination of Agroforestry in Uyui District are presented in Table 5. The ICRAF was the main facilitator of the various activities regarding the promotion of Agroforestry in the study area in collaboration with various stakeholders (Table 2).

Table 5: Dissemination approaches of AF technologies in Uyui District on which initial training was focused

Number of activity	Activities on which training was carried out
1	Sensitization (i.e. farmers and policy makers)
2	Training (i.e. extension staff and farmers - through short courses, seminars /workshops and farmer visits)
3	Formation of farmers' groups (i.e. Agroforestry groups)
4	Supply of tree seeds (i.e. collection and distribution) and tree plants to farmers

Source: DALDO (2003).

Table 6 indicates the impact of the various extension approaches on disseminating the Agroforestry information to the target farmers while Table 7 presents the impact of the various collaborating institutions in supplying the required germplasm to the local communities. It will be noted that the majority (i.e. 91%) of farmers practicing various agroforestry technologies learnt about them from more than one source of information e.g. from extension workers, seminars, and/or agricultural shows while only 9% of them indicated seminars to have been the only source. The ANOVA test shows that there are significant differences between the various sources of information about Agroforestry ($p<0.05$) and the LSD (Appendix III a) indicates that using village extension workers in combination with seminars should be most the effective means of promoting agroforestry to the communities in the study area. However, the ICRAF and ARI-Tumbi have jointly been the main supplier of the Agroforestry germplasm (Table 7).

Table 6: Source of agroforestry information for adopted farmers in Uyui District, Tabora Region, Tanzania

Source	Frequencies	Percentage* (n=42)
Village extension workers & seminars	16	38 a
Village extension workers	11	29 ab
Village extension workers, seminars & agricultural shows	7	17 bc
Seminars	4	9 bc
Village extension workers & agricultural shows	3	7 c
Total	**42**	**100**

*No significant different between percentages labelled with the same letter when tested with LSD

Table 7: Source of planting materials (seeds or seedlings) disseminated in Uyui District, Tabora Region, Tanzania

Source	Frequencies	Percentage** (n=42)
ICRAF /ARI- Tumbi	25	42 a
District agric office(Government)	14	23 b
Tobacco company	12	20 b
From other farmers in the village	6	10 c
From own farms	4	5 c
Total	**61***	**100**

* Total frequencies are high than sample size indicating that some farmers got planting materials from more than one source.
** No significant different between percentages labelled with the same letter when tested with LSD

4.2 Agroforestry technologies promoted and adopted in Uyui District

The results on the various Agroforestry technologies being promoted and adopted in Uyui District are presented in Table 8.

It will be noted that the ‘Improved fallow’ and ‘Woodlots’ technologies were significantly the most widely promoted and adopted by the local communities in the study area (i.e. 43 % and 30% respectively) with the fodder bank being the least ($p<0.05$) – probably because the low soil fertility and scarcity of wood based products were the main incentives and free range grazing limited adoption of the ‘fodder bank’ technology. Table 9, on the other hand, provides a list of tree species that were being promoted for Agroforestry use in the study area and levels of preference by the local community with *Acacia crascarpa* being overwhelmingly the most preferred (i.e. 42%) due to its being the most drought tolerant and faster growing. It will, also, be noted that the tree species used in the various technologies are indicated in Table 10.

Table 8: Agroforestry Technologies adopted by local communities in Uyui District, Tabora Region, Tanzania

Agroforestry technology	Frequencies	Percentage** (n=42)
Improved fallow	26	43 a
Woodlots	18	30 ab

Boundary planting	10	17 b
Fodder bank	6	10 b
Total	**60***	**100**

* Total frequencies are high than sample size indicating that some farmers adopted more than one agroforestry technology.
**No significant difference between percentages labelled with the same letter when tested with LSD

Table 9: Species promoted and adopted in Uyui District

Species	**Frequencies**	**Percentage (n=42)**
Acacia	34	42
Gliricidia sepium	8	10
Leucaena leucocephala	8	10
Senna siamea	6	7
Sesbania sesban	6	7
Acacia jurifera	4	5
Azadirachta indica	4	5
Moringa oleifera	4	5
Elaeis guinensis	2	3
Acacia albida	1	1
Acacia angustisma	1	1
Acacia polyacantha	1	1
Acacia aucoliformis	1	1
Bamboo	1	1
Total	**81** *	**100**

* Total frequencies are high than sample size indicating that farmers use various tree species to plant in their fields.

Table 10: The tree species used in the various Agroforestry technologies in Uyui District

Species	**Technology**
Gliricidia sepium and *Sesbania sesban*	Improved Follow
Acacia crascarpa, A. jurifera,A. aucoliformis, A. leptocarpa and *Azadiachta indica*	Woodlots
Acacia crascarpa, A. jurifera,A. aucoliformis, A. leptocarpa and *A..indica*	Boundary Planting
Grilicidia sepium, Acacia angustissima and *Leucaena leucucephala*	Fodder bank

4.3 Benefits gained by farmers of Uyui District through adoption of the Agroforestry technologies

The results on the benefits gained through practicing various agroforestry technologies as mentioned by respondents are presented in Table 10. The ANOVA test indicated that the benefits gained by farmers through adopting promoted agroforestry technologies are not significantly different - implying that all of the adopted Agroforestry technologies provide a similar range of magnitude of products and services (Appendix 5). However, it will be noted that most (i.e. 43%) of the population started practicing promoted Agroforestry technologies in recent years and thus have not yet started realizing the medium and long-term benefits from promoted Agroforestry technologies. However, the benefits have been accrued to the community with 20% already getting fuelwood, poles and other various products including monetary benefits.

Table 11: Benefits gained by the Uyui farmers in Tabora through adoption of Agroforestry technologies

Benefit	Frequencies	Percentage** (n=42)
Have not yet realized any benefit	22	43 a
Fuelwood, poles, fodder	10	20 a
Income through selling Agroforestry products	9	17 a
Shade, boundary marker(protective benefit)	8	16 a
Improve soil fertility	2	4 a
Total	**51***	**100**

* Total frequencies are high than sample size indicating that a farmer can get various benefit when practising agroforestry technologies.
** No significance difference between percentages labelled with the same letter, resulted from ANOVA

The benefits were categorized into productive, protective and socioeconomic. Estimation given in terms of Tshs per unit sold or yield per unit area were obtained during discussion with key informants and are presented in Table 12.

Table 12: Yield and income estimate of some of the Agroforestry products found in Uyui District, Tabora Tanzania

Type of benefit(s)	Estimates on yields/household	Price /Unit (Tshs)*	Income/household/year (Tshs)
Increase maize yields	From 1.0 ton/ha to 1.6-2.0 ton/ha.	nd	Nd
Fuelwood	6 bundles(0.4 ton/bundle)	nd	Nd
poles	12 poles	800	9 200
seeds	12kg	3 000	36 000

* 1US$ = Tshs 1, 115 in 2007.

nd = not determined

4.4 Constraints in dissemination of Agroforestry technologies and corrective measures required for improvement

4.4.1 Constraints in dissemination of Agroforestry technologies

The results on the various constraints that affect adoption of Agroforestry technologies being disseminated to the Uyui District communities are presented in Table 13. It will be noted that lack of skills was significantly the most constraining factor in adopting the technologies being disseminated, probably resulting from the shortage in the Agroforestry extension staff.

Table 13: The constraints that limit adoption of Agroforestry technologies being promoted in Uyui District, Tabora, Tanzania

Constraints	**Frequencies**	**Percentage**** (n=78)
Inadequate skills	42	41 a
Shortage/lack of land	18	18 b
Discrimination in the provision of extension service	13	13 b
Provision of un-preferred tree species	12	11 b
Unreliable rainfall/Drought	10	10 b
Lack of Germplasm (i.e. seeds/seedlings)	7	7 b
Total	**102***	**100**

*. Total frequencies are high than sample size meaning that a farmer could be limited by more than one factor in the adoption of agroforestry technology.

** No significance difference between percentages labelled with the same letter when tested with LSD

The results on the various constraints that affect the management of adopted Agroforestry technologies by the communities in Uyui District, on the other hand, are presented in Table 14 and the detailed information and statistical analysis and contrasts are presented in Appendices VIa and VIc.

Table 14: Constraints in effective management of adopted Agroforestry technologies being promoted

Constraint/problem	Frequencies	Percentage** (n=42)
Drought	34	35 a
Destruction of crops and trees by pests	35	32 a
Wildfire	18	18 a
Inadequate skills in managing both crops & trees	10	10 b
Destruction /theft of planted trees by other people	5	5 b
Total	**99***	**100**

*Total frequencies are high than sample size implying that a farmer faces more than one problem when practising agroforestry technologies

** No significant different between percentages labelled with the same letter when tested with LSD

It will be noted from the table that drought, destruction of plants by pests (i.e. straying animals and insects e.g. termites) and wildfires are the major constraints in managing Agroforestry technologies in the study area.

4.4.2 Corrective measures required for improvement

From the results on the respondents' views on corrective measures required for improvement of Agroforestry technologies dissemination in Uyui District (Table15), it will be noted that the local communities suggest augmentation in germplasm supplies, community sensitization and training, and improvements in the extension services delivery as priority corrective measures that could significantly enhance the Agroforestry dissemination process in Uyui District. On the basis of the observed enthusiasm in the local peoples' involvement in the collection, processing and marketing of wild fruits and their various products and, also, the urge they show, especially the elderly men, in seeking honey from the natural forests, the author is in the opinion that if Apiculture and domestication of indigenous and other fruit trees formed part of the priority corrective measures, could very positively contribute to the enhancement of Agroforestry dissemination and socio-economic welfare of the smallholder farmers in the district.

Table 15: The suggested corrective measures for improving the dissemination of Agroforestry technologies in Uyui District

Suggested corrective measures	**Frequencies**	**Percentage** ** **(n=120)**
Improvement and sustenance of provision of germplasm (i.e. seeds, seedlings, grafts, cuttings)	61	25 a
Sensitization and training	58	23 a
Improvement in extension services	53	22 a
Strengthening of farmers groups formation	32	13 b
Establishment of demonstration plots	24	10 b
Legislation and enforcement of laws and bylaws	17	7 b
Total	**245***	**100**

* Total frequencies are high than sample size indicating that a farmer mentioned more than one suggestion as corrective measures for improving agroforestry technologies dissemination.

** No significant difference between percentages labelled with the same letter when tested with LSD

CHAPTER FIVE

5.0 DISCUSSION

5.1 The origin and dissemination status of Agroforestry in Uyui District

The results on the origin and dissemination of Agroforestry in Uyui District are presented in Tables 2, 3, 4, 5, 6, 7 and Appendices IIIa - IIIc.

Although the strategies for wider dissemination of Agroforestry started in 2001 whereby various approaches were used, until the year 2006 only 10% of the population had adopted. This implies that the rate of adoption is still low. On the other hand the level of Agroforestry adoption in Uyui District started gradually and picking up from the 2004 cropping season as a result of built up awareness following the concerted campaigns by various institutions and extension services especially through use of local extensionists and seminars. The combined effectiveness of these dissemination approaches in promoting agroforestry adoption observed in the present study is in full agreement with the findings of various researchers reported for the same area (Bakengesa, 2001; Mlenge, 2004; Ajayi *et al*., 2006a; Msuya *et al*., 2006) and elsewhere in Africa e.g. Kenya (Jama *et al*., 2004) and Zambia (Kabwe *et al*., 2002), Asia and Latin America (Scarborough *et al*., 1997). The positive roles and varied impacts of the dissemination agents in influencing effective adoption of innovations are similarly in concurrence with the findings reported earlier for the same area and elsewhere (Bunderson *et al*., 2002; ICRAF, 2002; Ajayi *et al*., 2006a; Franzel *et al*., 2006; Oduol *et al*., 2006).

5.2 Agroforestry technologies promoted and adopted in Uyui District

Results on the various Agroforestry technologies being promoted and adopted in Uyui District are presented in Tables 8, 9, 10 and the details in Appendix IV.

The adoption of a particular technology is said to be attributed by the tree product the individual farmer wanted, the ability of the technology in solving the existing problem(s), the size of land an individual farmer owns and gestation period it takes until the farmer realizes benefits thus, technologies with short-term benefits are more preferred by most farmers (Raintree, 1983; Bakengesa, 2001; James, 2004). Of the four promoted technologies, Improved fallow and Woodlots technologies were most widely adopted by the local communities. In discussion with farmers as well as key informants, the researcher discovered that acceptance of these two agroforestry technologies promoted depended on the benefits that are offered by the technology. Both Improved fallow and Rotational woodlots were reported to have several benefits within short time of establishment e.g. improving soil fertility, providing fuelwood and other valuable products such as building poles and ropes (Ajayi et al., 2006b; Gama *et al*., 2002). Also this agrees with Alavalapati *et al*. (1995) who reported that technologies that take a long time period for their benefits to be realized may not be affordable to subsistence farmers.

Plate 1: A farmer in the foreground of the Woodlot established in 1998 in Isikizya village, Uyui District

Field observation on rotational woodlots revealed that most of the farmers do not cut trees that eventually turn to be permanent (Plate1). This situation was observed in Isikizya and Magiri Villages where farmers were the first to practice rotational woodlots (i.e. they were involved in on-farm trials, type II research trials).

On the other hand, the choice of tree species is largely determined by its characteristics. For example A. *crascarpa* seems to dominate in the study area due to its fast growth and environmental resilience. Farmers evaluated *A. crascarpa* as fast growing, resistant to drought, potentially produce high fuelwood and wood for construction. Other species accepted are *G.sepium*, and *L. leucocephala* for their ability to provide part of solutions to existing problems i.e. low soil fertility. The remaining species were just introduced to farmers in recent years this might contributed to their low adoption. The present findings are supported by observations from other studies. (Eckman and Hines, 1993; Ramadhani *et al*., 2002; Lengkeek, 2003; James, 2004; WAC, 2006).

During field observations most farmers were also found to plant indigenous trees in their fields or retained them field clearance prior to crop planting for different uses e.g. fuelwood, shade, building materials and sometimes indigenous fruits (Appendix VII). Farmers and key informants mention that indigenous trees were more preferred than exotic trees due to their drought tolerance and disease resistance. The preferences of the indigenous tree species have been also reported elsewhere (Mangaoang and Pasa, 2003).

5.3 Benefits gained by farmers of Uyui District through adoption of the Agroforestry technologies

Results on the benefits gained by farmers of Uyui District through adoption of the Agroforestry technologies are presented in Tables 11 and 12 with details presented in Appendix V.

It is common knowledge that agroforestry technologies do provide a wide range of products and services to farmers due to their diversified components (Rocheleau *et al.*, 1988; Young, 1990; Nair, 1993; Zeng, 1999: Ajayi *et al*., 2003; Jama *et al.*, 2004; Ajayi *et al*., 2006a). However the present study found that most farmers practicing agroforestry have just started realizing a limited range of the benefits from promoted Agroforestry technologies mainly because most of them were initiated very recently and haven't yet started producing the expected results. It is important to note that benefits obtained through practicing agroforestry depend largely on the type of benefits anticipated, age of the various components since establishment, type of component species planted and arrangement of components in the technology. The findings of early realization of some of the benefits such as crop yield increases, fuelwood, poles and increases in soil fertility from improved fallows, fodder yields from fodder banks, and income accruing from the sales of surpluses of some of such products, have similarly been reported variously elsewhere (Kwesiga *et al*., 2003; Thangata and Alavalapati, 2003; Ajayi *et al.,* 2006a). Within the period of 5 - 8 years of Agroforestry dissemination in the current study area, for instance, the local communities realized increases of 60% to 100% in maize yield when *Grilicidia sepium* and *Sesbania sesban* tree species were used and mean annual household income of approximately US$ 40.5 (Tshs 45 200) from the sales of building poles from *Acacia crascarpa, A. jurifera, A. leptocarpa* and *Azadirachta indica* and various tree seeds. The above observation shows that Agroforestry technologies are useful in achieving the National Strategy of Growth and Reduction of Poverty (NSGRP) goals, in Kiswahili commonly known as MKUKUTA which include; improving food security (i.e. food availability and accessibility), and reducing income poverty for both men and women in rural areas. Remarkable crop yield increases when some tree species such as *Grilicidia sepium, Sesbania sesban and Tephrosia vogelii* are incorporated in Agroforestry management systems have earlier been reported from trials in the same area (Gama *et al*., 2002 and Matata *et al*., 2006) and elsewhere (Kwesiga and Coe, 1994; Ajayi *et al*., 2005 and Franzel *et al*., 2006). The benefits could, most likely, have been much higher had the systems' components included other early yielding species, such as fruits and vegetables. The long waiting time required before realization of more valuable wood products makes the Rotational woodlots and Boundary planting technologies be less favoured by the local communities in Uyui District. But if these technologies reached many farmers and got adopted, they could significantly help in reducing wood biomass utilization pressure building up around the Miombo woodlands while, at the same time improving their livelihoods through income generation.

5.4 Constraints in dissemination of Agroforestry technologies and corrective measures required for improvement

The results on the constraints that affect dissemination and adoption of Agroforestry technologies in the communities in Uyui District are presented in Tables 13 and 14 and Appendices VIa-VIc. The results on the corrective measures required for improvement of dissemination and adoption are presented in Table 15.

The finding of inadequate skills as the main constraining factor that limits dissemination and adoption of Agroforestry technologies agrees well with the findings reported variously elsewhere (Ajayi *et al*., 2006a). This indicates insufficiency in the provision of extension services that would have provided the vital skills to the people. The reports by Yaron *et al*. (1992) and James (2004), emphasize the influence of extension services on technology innovations. Kalineza *et al*. (1999), while researching in Gairo, Morogoro, Tanzania, similarly found that extension and education services catalyzed awareness, organization and information exchange, thus, resulting in increased knowledge that in turn promoted the adoption of new soil conservation technologies. The positive role of extension services and skills in promoting the adoption of new technologies had, also earlier been reported for Niger (Baidu-Forson, 1999) and Zambia (Ajayi *et al*., 2003; Ajayi *et al*., 2006a). This problem, however, can only be effectively addressed through provision of adequate extension staff with the appropriate skills, adequate education and motivation.

The problems of land tenure, lack and inadequacy in the amounts of preferred species by the local people, have also been variously reported elsewhere. In India, for example, possession of land is said to be a necessary condition for adoption of Agroforestry technologies (Alavalapati *et al*., 1995). In Cameroon it is the competition between trees and herbaceous crops that exists in the small land holdings that limit Agroforestry adoption (Adesina and Coulibaly,1998) while in Zambia the constraints result from cost, credit possibilities, land size and availability and risk considerations (Feder *et al*., 2003; Ajayi *et al*., 2003), in South America observes that, it is land tenure and rights to tree ownership (Randy *et al*., 2005), and in Tanzania, it is land ownership (MNRT, 2003; Msuya *et al*., 2006). The factor of availability and preference for some desirable tree species has, also, been widely reported (Eckman and Hines 1993; Bohringer *et al*., 2003; Mangaoang and Pasa, 2003; James, 2004; WAC, 2006). For agroforestry technologies to be widely disseminated there should be sustainable supplies of agroforestry tree seeds that meet the needs and priorities of small scale farmers.

On the other hand, in this study the constraining factors on effective management of adopted Agroforestry technologies being promoted are; drought, crop and tree pests and wildfires. These are in line with the findings reported elsewhere in this country (Bakengesa, 2002; Mumba *et al*., 2002; Ramadhani *et al.*, 2002; Mnyenyelwa, 2004; Msuya *et al*. 2006), Zambia (Kabwe *et al*., 2004) and. Southern Asia (Guzman, 1999). Prevalence of drought affects both tree nursery establishment and field planting activities. Interviewed farmers as well as focus group discussion members mentioned that the area experienced unreliable rainfall during most of the programme period and was aggravated by the generally infertile soils with poor water holding capacities. To effectively solve this problem, it is being strongly suggested that future programme efforts get increasingly focused on the establishment of community based and carefully timed tree nurseries activities in relation to the incidence of the rain seasons including provisions for rain water harvesting strategies. The problems of pests, especially termites and nematodes, wildfires and diseases that mildly constraints the adoption of Agroforestry in the study area are a general feature in most dry environments (Ajayi *et al.*, 2006b; Franzel *et al*., 2006).

Although insignificant application of appropriate pesticides and careful technology management, would be required to limit these constraints.

The indication of improvement and sustenance of provision of germplasm, community sensitization and training, and improvements in the extension services delivery as being the priority corrective measures that could significantly improve in the dissemination and adoption of various agroforestry technologies, is in line with the findings reported globally. The need for the provision of the required germplasm, mainly in the form of seed and tree plants (i.e. seedlings), has variously been reported to be a critical factor in enhancing scaling-up of agroforestry and its various technologies (Gama *et al*., 2002; Thangata and Alavalapati, 2003; Ajayi *et al.,* 2006a). Sufficient budgetary allocation should, therefore, be made available for ensured provision of adequate and sustainable diverse and quality germplasm in any Agroforestry intervention programme. This, in turn, be reinforced by sensitization and training of the involved local communities that equips them with the required knowledge and skills including, where applicable, use of available legislations and by-laws (Oluko *et al*., 2000; Mnyenyelwa, 2005**).** There is, also, a need to build up the agroforestry dissemination capacity at various levels (i.e extension staff, councillors, researchers and policy makers). Various extension approaches suggested include workshops, seminars, field days, farmer to farmer visits, farmer groups and demonstration plots. The observation of increased technology adoption by farmers through increasing contacts with extension agents has, similarly, been reported by various studies elsewhere (Baidu-Forson, 1999; Kalineza *et al*., 1999; Adesina *et al*., 2000; Franzel *et al*., 2001; Mnyenyelwa, 2005; Ajayi *et al*., 2006a).

The author's observation for the need to bring into the agroforestry dissemination programme fruit trees and apiculture in order to further increase and diversify benefits to the local communities is supported by the findings reported elsewhere (Leakey *et al*., 2003; Gonzales-Soberanis and Casas, 2004; Mwakatobe and Mlingwa, 2005). It is worth stressing that in densely populated areas use of stingless bees need to be actively encouraged for use of stinging bees may be a potential hazard notably to livestock and children.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Basing on the results and preceding discussions the following conclusions have been made:

i. The ICRAF through the SADC/ICRAF agroforestry research project at the ARI-Tumbi was the originator of the Agroforestry programmes in the district. In collaboration with several institutions assisted reaching farmers through directed training in order to impart knowledge of agroforestry to extension staff, farmers and policy makers also provision of various tree germplasm (i.e seeds and tree plants).

ii. Currently 10% of the Uyui District communities have adopted and practiced various Agroforestry technologies.

iii. Both the tree species and technology characteristics contribute to the technology's acceptability. About four technologies are being disseminated to farmers from which "Improved fallow" and "Woodlots" technologies are the most widely accepted and adopted by the local communities in the study area.

iv. Some benefits gained by farmers through adopting agroforestry include productive, protective and socioeconomic benefits. However most of the population started practicing promoted Agroforestry technologies in recent years and thus have just started realizing the early manifesting benefits expected from promoted Agroforestry technologies.

v. Various constraints affect dissemination and adoption of Agroforestry technologies in the community these include inadequate skills, shortage/lack of land, drought and destruction of crops and trees by pests and wildfires. However the following corrective measures were suggested for improvement; sustainable seed availability of the tree germplasm, sensitization and training of farmers, improvement in extension services, formation and strengthening of farmers groups, legislation and enforcement of laws and bylaws, integration of fruit trees, and apiculture in Agroforestry, application of appropriate pesticides and careful technologies management.

6.2 Recommendations

The following recommendations are aimed at addressing issues raised in the discussion and conclusions:

i. Agroforestry promotion efforts need to be increased in order to reduce the escalation of deforestation, soil degradation and reduce fuelwood shortage in Uyui District.

ii. Training of local communities on the skills of suitable agroforestry plant husbandry need immediate initiation in order to enable them to establish their own backyard or community based tree nurseries to sustain their annual tree seedling supplies.

iii. The introduction of water harvesting techniques that will supply water for irrigation of tree/seedlings during drought period can be one of the strategies to ensure that annual AF activities commence at the recommended time.

iv. Farmers should be provided with different valuable tree species, this will enable farmers to meet their preferences and circumstances. If this is considered it is likely to make promoted agroforestry technologies more profitable and therefore increasingly encourage farmers' participation.

v. Enforcement of forestry rules, bylaws and regulations against tree cutting and deforestation will reduce or control cutting trees from natural forests and thus enhance adoption of promoted Agroforestry and maintain supply (provision) of various products and services. It is therefore recommended that meetings to discuss achievements of agroforestry scaling-up initiatives and sharing experiences, be regularly convened.

vi. Domestication of indigenous and other fruit trees needed to be included in the programme.These in turn help to reduce degradation of the forests and the environment also provides alternative income sources including balanced diet and food security.

vii. Apiculture has a great potential of contributing to poverty reduction and food security through additional income generation, job creation and improving biodiversity. To make this realizable, there is an urgent need for establishment of collaboration between researchers, extension agents, NGO's and policy makers in order to support the community in fully utilize existing Agroforestry potentials.

However the last two recommendations (i.e.intergration of apiculture and fruit trees in the dissemination of agroforestry technologies), need further research to investigate the socioeconomic and biophysical constraints to their development.

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APPENDICES

Appendix I: Farmers questionnaire

This questionnaire for households aimed at seeking information on the dissemination status of Agroforestry in Uyui District, Tabora Region. The information provided will help to determine the status of agroforestry dissemination, the technologies being promoted and benefits the communities get from their adoption and constraints to their scaling up and interventions required for improvement.

Part A. Background Information.

A1.Date.....................................

A2. Division............................

A3. Ward..................................

A4. Village..............................

A5. Household No.......................

A6.What is your occupation.

1. Employee (specify)
2. Religious leader
3. Village council leaders.
4. Ten cell leader
5. Peasant.
6. Petty business
7. Other (Specify). [ ]

A.7.For how long have you been in this village………..years

A8. How did acquire this land?

1. Purchase.
2. Inherited
3. Given by the village council.
4. Acquired through clearing of open access forestry/bush land.
5. Others (specify). [ ]

Part B. Farm size and Land Use.

B.1. Is your farms land enough for farming activities? 1. Yes. 2. No. [ ]

B.2. Is it possible to acquire more land? 1. Yes 2.No. [ ]

B.3. If yes in 2, how?

B.4 If no in 2, why?

B.5. Are you retaining indigenous tree species in your field? 1. Yes.2.No [ ]

B.6.If yes in 5 which indigenous tree species do you prefer to retain/ plant in your farm and what are the uses/functions of retained trees?

Common name	Scientific name	Uses/function

B.7 .Do trees planted in your farm meet your daily requirements (forest related products)?

1. Yes

2. No. [ ]

C: Agroforestry Technologies Dissemination and Adoption

C1.Have you heard about Agroforestry? 1. Yes. 2. No

C2.Do you practice agroforestry?

1. Yes

2. No [ ]

C3.If No, Why?

C4. If Yes in C1, where did you hear and learn about agroforestry?

1. Neigbour

2. Extension staff/officer

4. Agriculture show

5. Seminar/workshop.

6. Other (Specify) [ ]

C5. Where do you get planting materials (seeds)

C6.When did you start practicing agroforestry?

C7.Which Agroforestry tree/shrub species do you prefer to plant in your farm and what are the reasons for your preference?

Tree species	Reasons for your preference
1. 2. 3. 4. 5.	

C8. What practices (Technology) do you use to grow trees in your field?

1. Improved fallow
2. As a woodlot
3. Boundary planting
4. Fodder bank
5. Other (specify)

C9 What kind of benefit do you get from agroforestry?

1. Improve soil fertility
2. Income through selling agroforestry products
3. fuel wood, poles, fodder
4. shade, boundary marker
5. others (specify)

C10. Is there any extension officer serving your village? 1. Yes. 2. No. [ ]

C11.If, yes, how often does he/she visit your home?

1. Rarely
2. Very often
3. During growing season.

C.12.Has he/she ever advised you on agroforestry practices?

1. Yes. [ ]
2. No. [ ]

C.13.Does the village government has any bylaw concerned deforestation?

1. Yes [ ]
2. No. [ ]

C.14.If yes what does it state concerning promotion of agroforestry?

D: Constraints to Agroforestry technologies at Households level

D.1What problem do you face in the management of adopted Agroforestry technologies at your home?

D.2.What could be the reasons of the problems above?

E: Respondent's View on corrective measures in the dissemination of Agroforestry technologies in the study area.

E.1. what would you recommend /suggest in order to improved promotion of agroforestry technologies in this area?

THANK YOU FOR YOUR COOPERATION

Appendix II: Checklists of probe questions for various key informants

2.1 Checklist for Extension Staff (Agricultural, Forest and Community Development Officers)

1. For how long has the agroforestry practices ha been promoted in the area?

2. What is the current agroforestry extension approaches used in this area?

3. What is the level of adoption of agroforestry technologies being promoted in this area for last five years?

Agroforestry Technology	**Years**				
	2001	2002	2003	2004	2005
	No.of adopters	No.of adopters	No.of adopters	No.of adopters	No.of adopters
Total					

4. What constraints does the community face in implementing agroforestry?

5. What extension approaches do you think would be appropriate in helping promotion of agroforestry in this area?

6. Is there any by law restrict people from causing deforestation? (Yes / No

7. If yes how do you rate its effectiveness?

2.2 Checklist for District/Village Leaders/Special group of farmers

1. Who are promoting agroforestry in your area of management?

2. What kind of agroforestry products/benefits do the communities obtained through practicing various agroforestry technologies? Give estimates.

3. Is there any problem(s) regarding the adoption of promoted agroforestry technologies? (Yes / No

4. If yes, what are the main causes of this/these problem(s)?

5. In your view (s) what could be done for the success of dissemination and adoption of agroforestry technologies in this area?

2.3 Checklist for Group Discussion with Interest Group (e.g. Women).

1. What are major activities performed by your group?

2. What benefits do you obtain through running your activities?

3. What do you think are the constraints in dissemination and adoption of Agroforestry technologies in the area?

4. What do you think should be done in order to improve dissemination agroforestry technologies in the community?

2.4 Checklist for Ex-Project Staff

1. Number of years at post……………………
2. What methods do you use to disseminate agroforestry technologies?
3. What problem are you facing in promoting agroforestry?
4. What factors do you think are affecting the adoption of improved agroforestry technologies?
5. What are your suggestions in order to improve dissemination and adoption of agroforestry?

THANK YOU FOR YOUR COOPERATION.

Appendix III a: Source of information

Percentage of Source of information *****

Source	Villages					
	Isikizya	Magiri	Kigwa	Nsololo	Mpenge	Mabama
Village extension worker	5	0	5	10	15	5
Seminar	5	5	0	5	5	0
VEW+Seminar	10	10	20	10	10	0
VEW+Seminar +Agr show	10	5	0	0	10	10
VEW+Agric.show	0	0	10	0	5	5

* Note: Percentage values were converted into Arcsin angle for ANOVA calculations.

CF = 3956.23

TSS = 1998.14

TrSS =1193.92

BSS = 244.16

ANOVA TABLE

SOV	Df	SS	MS	F-calc.	Ftab. $_{0.05}$
Treatment	4	1 193.92	298.48	10.66	4,20 = 2.87
Block	5	244.16	48.83	1.74	
Error	20	560.06	28.00=S^2		
Total	**29**	**1 998.14**			

LSD (Least Significant Different)

Lsd = (tv.α) S_d

Sd= $\sqrt{2*S^2/r}$

Sd = $\sqrt{2*28/6}$

Sd = 3.06

Hence Lsd = $t_{0.05}$. 20 * 3.06 = (1.725) (3.06) = 5.27

Treatment Means

16.72 13.33 11.37 8.61 7.38

a ab bc bc c

Appendix III b: Source of planting materials (seeds/seedlings)

Percentage of source of planting materials

Source	Village					
	Isikizya	Magiri	Kigwa	Nsololo	Mpenge	Mabama
ICRAF/ARTI-Tumbi	25	20	20	5	45	15
Government	10	10	20	20	5	0
Farmer to Farmer	15	5	0	0	5	0
Tobacco Company	5	20	10	0	20	5
Own Field	5	10	10	0	0	0

CF = 3956.23

TSS = 3770.52

TrSS =1427.61

BSS = 932.5

ANOVA TABLE

SOV	Df	SS	MS	F-calc.	Ftab.$_{0.05}$
Treatment	4	1 427.61	298.48	5.36	4,20 = 2.87
Block	5	932.54	186.51	2.78	
Error	20	1 410.00	67.143=S^2		
Total	**29**	**3770.52**			

Lsd (Least Significant Different)

Lsd = (tv.α) S_d

Sd = $\sqrt{2S^2/r}$

Sd = $\sqrt{2*67.143/6}$

Sd = 4.73

Hence Lsd = $t_{0.05}$. 20* 4.73 = (1.725) (4.73) = 8.12

Treatment means

26.83 17.15 16.23 8.11 8.30

a b b c c

Appendix III c: Level of adoption of agroforestry technologies

Percentage of adopters*

Villages	Years**				
	2001	2002	2003	2004	2005
Isikizya	0	5	15	35	45
Magiri	0	20	20	40	45
Kigwa	10	30	30	35	45
Nsololo	0	10	10	25	45
Mpenge	20	20	20	20	70
Mabama	10	25	25	35	35

*Based on sampled households

** Based on Phase II of the project i.e. wider dissemination programme

CF = 23 233.59

TSS = 5077.14

TrSS = 3 59

BSS = 569.7

ANOVA TABLE

SOV	Df	SS	MS	F-calc.	F-tab. $_{0.05}$
Treatment	4	3 590.97	897.742	19.59	4, 20 = 2.87
Block	5	569.73	133.946	2.96	
Residual	20	916.44	45.822=S^2		
Total	**29**	**5 077.14**			

LSD (Least Significant Different)

Lsd = (tv.α) S_d

Sd= $\sqrt{2*S^2/r}$

Sd = $\sqrt{2*45.822/6}$

Sd = 3.91

Hence Lsd = $t_{0.05.}$ 20*3.91= (1.725) (3.91) = 6.74

Treatment means

43.59 34.1 26.26 24.6 10.57

a b c c d

Appendix IV: Technologies promoted and adopted in Uyui district

Perentage of technologies adopted

Technology	Village					
	Isikizya	Magiri	Kigwa	Nsololo	Mpenge	Mabama
Improved fallow	20	20	25	10	40	15
Woodlots	35	20	10	0	15	10
Boundary planting	15	15	0	15	5	0
Fodder Bank	5	0	15	5	0	5

CF = 7665.52

TSS = 3009.40

TrSS = 1027.99

BSS = 341.27

ANOVA TABLE

SOV	Df	SS	MS	F-calc.	F-tab. $_{0.05}$
Treatment	3	1 027.99	342.66	3.13	3,15 = 3.06
Block	5	341.27	68.25	0.62	
Residual /Error	15	1 640.14	$109.34=S^2$		
Total	**23**	**105.44**			

LSD (Least Significant Different)

Lsd = (tv.α) S_d.

Sd = $\sqrt{2S^2 / r}$

Sd = $\sqrt{2*109.34/6}$

Sd = 6.04

Hence Lsd = $t_{0.05}$. 15* 6.04 = (1.753) (6.04) =10.59

Treatment Means

27.26 20.42 13.55 10.26

a ab b b

Appendix V: Benefits gained through practicing agroforestry

Percentage of adopters on benefit gained through practicing agroforestry.

Benefit	Village					
	Isikizya	Magiri	Kigwa	Nsololo	Mpenge	Mabama
Income through selling agroforestry products	30	5	10	0	0	0
Fuelwood, poles, fodder	25	10	15	0	0	0
Not yet realize any benefit	15	10	15	25	35	10
Shade, boundary marker	30	0	5	0	5	0
Improve soil fertility	0	5	0	0	0	5

CF = 4549.04

TSS = 5025.17

TrSS = 1370.66

BSS = 1124.5

ANOVA TABLE

SOV	**Df**	**SS**	**MS**	**F- value**	**F-tab $_{0.05}$**
Treatment	4	1 370.66	342.67	2.71	4,20 = 2.87
Block	5	1 124.50	224.90	1.78	
Residual /Error	20	2 530.01	126.50 =S^2		
Total	**29**				

Appendix VI a: The constraints that limit adoption of Agroforestry technologies being promoted in Uyui District

Percentage of the constraints that limit adoption of Agroforestry technologies

	Village					
Reasons	Isikizya	Magiri	Kigwa	Nsololo	Mpenge	Mabama
Inadequate skills	15	45	25	75	30	25
Discrimination in the provision of extension service	30	5	10	5	0	15
Shortage/lack of land	25	25	5	10	0	25
Provision of un-preferred tree species	0	5	0	20	25	10
Unreliable rainfall/Drought	5	10	0	0	20	10
Lack of Germplasm(i.e . seeds/seedlings)	0	0	15	5	5	5

CF = 12 306.20

TSS = 6679.13

TrSS = 2646.17

BSS = 304.1

ANOVA TABLE

SOV	Df	SS	MS	F-calc.	F-tab. $_{0.05}$
Treatment	5	2 646.17	529.23	3.55	5, 25 = 2.60
Block	5	304.15	60.83	0.41	
Residual /Error	25	3 728.81	149.15 $=S^2$		
Total	**35**				

LSD (Least Significant Different)

Lsd = (tv.α) Sd.

$Sd = \sqrt{2S^2 / r}$

$Sd = \sqrt{2*149.15 / 6}$

Sd = 7.05

Hence Lsd = $t_{0.05}$. 25*7.05 = (1.708) (7.05) = 12.04

Treatment means

36.36 20.23 16.71 14.65 12.73 11. 22

a b b b b b

Appendix VI b: Constraints in effective management of adopted Agroforestry Technologies

Percentage of constraints in effective management of adopted Agroforestry technologies

Constraint/Problem	Village					
	Isikizya	**Magiri**	**Kigwa**	**Nsololo**	**Mpenge**	**Mabama**
Drought	30	20	40	15	45	15
Destruction of crop and trees by pests	50	15	40	15	10	30
Wildfire	5	10	25	20	15	15
Inadequate skills	10	15	0	0	20	5
destruction/theft by other people	0	0	10	5	10	0

CF = 13 627.32

TSS = 4689.98

TrSS = 2469.65

BSS = 440.

ANOVA TABLE

SOV	**Df**	**SS**	**MS**	**F- calc.**	**F-tab.** $_{0.05}$
Treatment	4	2 469.65	617.41	6.94	4, 20 = 2.87
Block	5	440.5	88.00	0.99	
Residual /Error	20	1 779.83	88.99 $=S^2$		
Total	**29**				

LSD (Least Significant Different)

Lsd = (tv.α) S_d

Sd = $\sqrt{2*S^2/r}$

Sd = $\sqrt{2*88.99/6}$

Sd = 5.45

Hence Lsd = $t_{0.05}$. 20*5.45 = (1.725) (5.45) = 9.4

Treatment means

31.29 30.24 23.43 13.45 8.30

a a a b b

Appendix VI c: The suggested corrective measures for improving the dissemination of Agroforestry technologies in Uyui District

Percentage of the suggested corrective measures for improving the dissemination of Agroforestry technologies

Suggested corrective measures	**Village**					
	Isikizya	**Magiri**	**Kigwa**	**Nsololo**	**Mpenge**	**Mabama**
Improvement and sustenance of provision of germplasm (i.e. seeds, seedlings, grafts, cuttings)	35	60	60	25	70	55
Sensitization and training	50	45	40	60	20	50
Improvement in extension services	30	30	35	50	15	30
Strengthening of farmers groups formation	50	25	35	30	10	10
Establishment of demonstration plots	40	30	20	30	5	30
Legislation and enforcement of by laws and bylaws	10	25	10	20	5	15

CF = 40 918.60

TSS = 4493.66

TrSS = 2240.16

BSS = 583.7

ANOVA TABLE

SOV	**Df**	**SS**	**MS**	**F-calc.**	**F-tab $_{0.05}$**
Treatment	5	2 240.16	448.03	6.71	5,25 = 2.60
Block	5	583.77	116..75	1.75	
Residual /Error	25	1 669.73	66.78 $=S^2$		
Total	**35**				

LSD (Least Significant Different)

$Lsd = (tv.\alpha)\ S_d$

$Sd = \sqrt{2S^2/r}$

Sd = √2*66.78⁄6

Sd = 4.72

Hence Lsd = $t_{0.05}$. 25*4.72= (1.708) (4.72) = 8.06

Treatment means

45.41	41.45	33.95	30.23	29.72	21.53
a	a	ab	b	b	b

Appendix VII: Common indigenous trees retained/planted in the farmer's fields

Local/Swahili Name	**Scientific name***	**Uses**
Mbuguswa	*Flacourtia indica*	Fruits.firewood
Mfuru	*Vitex domiana*	Fruits.firewood
Mgando	*Burkea africana*	Fuelwood,timber,poles,,fooder (leaves,fruit),bee forage medicine
Mgunga	*Acacia nilotica/polyacantha*	Fuelwood, poles, medicine(roots), bee forage, nitrogen fixation, soilconservation, soil improvement, shelterbelts, live fences.
Mkola	*Afzelia quanzensis*	Timber(construction,furniture),carving(doors), medicines and shade
Mkuni	*Berchemia discolor*	Poles,timber(construction,furniture), medicine,beeforage,shade,windbreak.
Mkwaju	*Tamarindus indica*	Fruits. firewood
Mlugala	*Acacia mellifera*	Fuelwood, utensils, bee forage , medicine live fence, nitrogen fixation, soil conservation.
Mninga	*Pterocarpus angolensis*	Firewood, timber, medicines shade.
Mpogolo	*Albizia amara*	Fuelwood, timber, poles, medicine, fodder, mulch, nitrogen fixation, soil conservation
Mtalali	*Vitex mombassae*	Fruits. firewood
Mtonga	*Strychnos cocculoides*	Fruits. firewood
Mtundu	*Brachystegia spiciformis*	fuelwood, timber ,beehives, medicine, beeforage, shade, fibre rope bark
Mtundulu	*Dichrostachys cinerea*	Fuelwood, timber, poles, tool handle ,medicines,fodder, bee forage nitrogen fixation, soil conservation, fibre, live fences

* Source: Ruffo, *et al*. (2002), ARI- TUMBI Staff.