EFFECTS OF ROTATIONAL WOODLOTS ON HOUSEHOLDS' LIVELIHOOD IN MEATU DISTRICT, TANZANIA

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

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ABSTRACT

Meatu district in Simiyu region is one of the most degraded areas in Tanzania where the effects of deforestation were vivid resulting from increased population of both humans and livestock. The problem extends to the effect of soil degradation, poor crop yield, shortage of fuel wood, building materials and fodder. Rotational Woodlot (RWL) was the most promising tested technology to solve the problem. The objective of this study was to assess the effects of rotational woodlots on households' livelihood. The study was carried out in two wards, two villages per ward and thirty households from each study village. Both primary and secondary data were collected to address the objectives. Methods used for primary data collection included household survey, key informant interviews using a checklist and direct observation. Literature survey was done to obtain secondary data. Qualitative data was analyzed using content analysis while quantitative data was analyzed through a Statistical Package for Social Sciences (SPSS) computer soft ware version 12. Result indicated that 44.4% of total household income and 62.0% of the total household food produced was obtained from rotational woodlots. Socio-economic factors which enhanced household incomes were: age of household head, land ownership, food produced from rotational woodlots while constrained factors were: sex and education level of the head of the household, land under RWL and household size. Socio-economic factors which enhanced household food security were: sex and occupation of the head of the household, size of the household, land under RWL and income from RWL. The constraining factors were: age, education level of the head of household, the rights to land. The study concludes that, RWL has positive effect on household's income and food security. Based on the socio-economic findings it is recommended that RWL be up scaled through establishing tree nurseries in the villages, as well as recruiting more extension staff and conducting frequent monitoring and evaluation in the villages practising

rotational woodlots. Moreover, there is need of taking into consideration socio-economic factors that enhance and constrain RWL based on income and food security.

DECLARATION

I, AGNES ALPHONSE RUBOYA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution

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LIST OF ABBREVIATIONS

COSTECH	Commission for Science and Technology
DALDO	District Agricultural and Livestock Development Officer
DEO	District Extension Officer
DFID	Department for International Development
DNRO	District Natural Resource Office
DPLO	District Planning Officer
FAO	Food and Agriculture Organization of the United Nations
Ha	Hectares
HASHI	Hifadhi Ardhi Shinyanga (Shinyanga Soil Conservation Programme)
HH	House Hold
HIV/AIDS	Human Immune Deficiency Virus/Acquired Immune Deficiency Syndrome
ICRAF	International Center for Research in Agroforesty
MAFSC	Ministry of Agriculture Food Security and Co-operatives
MNRT	Ministry of Natural Resource and Tourism
MNRSA	Management of Natural Resource for sustainable Agriculture
MTPS	Multipurpose trees
NAFRAC	Natural Resource Management and Agroforestry Centre
NGO	Non Governmental Organization
RWL	Rotational Woodlot
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences

SUA	Sokoine University of Agriculture
TAS	Tanzania Shilling
TFNC	Tanzania Food and Nutrition Centre
URT	United Republic of Tanzania
VEO	Village Executive Officer

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Since 1970s, Agroforestry has been recognized as a traditional land use practice (Bakengesa, 2001). The practice started as a distinct sustainable land management system that led to an overall increase of land yields. The practice involved combining crop production, trees and animals simultaneously or sequentially, on the same unit of land and applying management practices that were compatible with cultural practices of the local population (Kitalyi *et al.,* 2010). Among the most documented traditional agroforestry systems in Tanzania include; Chagga home-gardens (kihamba), Mara region home-gardens known as "obohochere", Kagera region 'kibanja' and the traditional Wasukuma silvopastoral system found in Shinyanga called "ngitili" (Kitalyi, 2010).

In Tanzania, projects on Agroforestry Research and Development were initiated to address massive environmental degradation, deforestation, and declines of soil fertility. Other problems addressed include shortage of fuel wood and fodder for domestic animals (Otsyina and Asenga, 1994). Tabora and Shinyanga regions were the first beneficiaries of the projects and whose main objectives were to develop and accelerate agroforestry technologies, build a network of partners in agroforestry development and improve marketing of agroforestry products and services. Among the systems developed include rotational woodlots, improved fallow systems, home gardens, and improved indigenous land use systems (Otsyina *et al.,* 1996).

In Tanzania, Agroforestry is instrumental in realizing the desired outcomes of Poverty Reduction Strategy (Kitalyi, 2006). For years, the prime objective of agroforestry research and development has been to increase food production, provide raw materials and raise income and consequently help to achieve the Millennium Development Goals (Kitalyi, 2006). Many regions in Tanzania are presently facing severe shortages of fuel wood, fodder and food primarily associated with low crop productivity due to increasing human and livestock populations, coupled with little or lack of external inputs (FAO, 2003).

Shinyanga region and Meatu district in particular is dominated by the Sukuma agro-pastoral community. The district is reported to be one of the most degraded areas in the country resulting from increased population of both humans and livestock (Otsyina *et al.*, 1996). Agroforestry research and development was introduced in the area by the International Centre for Research in Agroforestry (ICRAF). In 1991, ICRAF established its site in Shinyanga and operated in collaboration with Shinyanga Soil Conservation Programme (HASHI). According to Otsyina *et al.* (1996), through ICRAF project, agroforestry has promoted tree integration with crops and has helped to solve some of the identified land use problems in Shinyanga region. (Otsyina *et al.*, 1996).

1.2 Problem Statement and Study Justification

Agroforestry Research and Development in Tanzania has been in operation for over two decades. It started as a response to address deforestation, soil degradation, and poor crop yield, shortage of fuel wood, building materials, fodder and grazing land. The government of Tanzania through HASHI in collaboration with ICRAF worked hard in disseminating tested technologies, such as Rotational Woodlot and Improved Fallow (Mechanic *et al.*, 2003).

In Meatu district formerly in Shinyanga region but currently under Simiyu region, the effects of deforestation are vivid. The soils were depleted of vegetation, firewood became a scarce commodity and supply of quality fodder was low (Mumba, 1999). Development of sustainable technologies that combine wood production and cropping phases on farms were introduced to address the above problems. These included initial tree establishment phase in which trees are intercropped with crops and followed by a tree fallow phase and lastly cropping phase after harvesting the trees. Meatu is one of the districts where Rotational Woodlot was introduced and was the most promising tested technology whose envisaged additional benefits include food, fodder, soil and environmental improvement (Otsyina and Asenga, 1993).

Several studies have been conducted in semi arid parts of Tanzania; such studies focused on economics of RWL, soil fertility, crop and wood yields, evaluation of RWL using different multipurpose trees (MTPs), socio-economic advantages of RWL, farmers perceptions on utilization of RWL and factors influencing its implementation (Mumba,1999).

In spite of the importance of the RWL in sustaining household livelihoods in Tanzania, little has been done on the effects of RWL on household's income and food productivity, as a surrogate of livelihoods. This study therefore aimed at assessing the effect of RWL on household income and food security as well as determining socio-economic factors underlying performance of RWL in Meatu District. The results of this study are expected to provide basic information to researchers, policy makers, NGOs and other relevant stakeholders in Meatu District and the nation at large, on the contribution of RWL to household income and food productivity.

1.3 Objectives

1.3.1 Overall objective

To assess effects of rotational woodlot on households' livelihood in Meatu District.

1.3.2 Specific objectives

Specific objectives of the study were

i. To assess the contribution of rotational woodlot on household income and food security as a surrogate of household's livelihood.
ii. To determine the socio-economic factors underlying performance of rotational woodlots.

1.4 Research Questions

i. What is the contribution of rotational woodlot on household income?
ii. What is the contribution of rotational woodlot on household food security?
iii. What are the socio-economic factors underlying the performance of rotational woodlot specifically to household income and food security?

1.5 Conceptual Framework

The conceptual framework (Fig. 1) is a diagrammatic presentation of variables studied and the hypothetical relationships between and among the variables, and it provides guidance toward collection of data and information (Mbwambo, 2007). RWL is singled out as a promising agroforestry technology in Meatu. RWL is aimed at improving soil fertility and crop productivity, but its performance is influenced by different socio-economic factors.

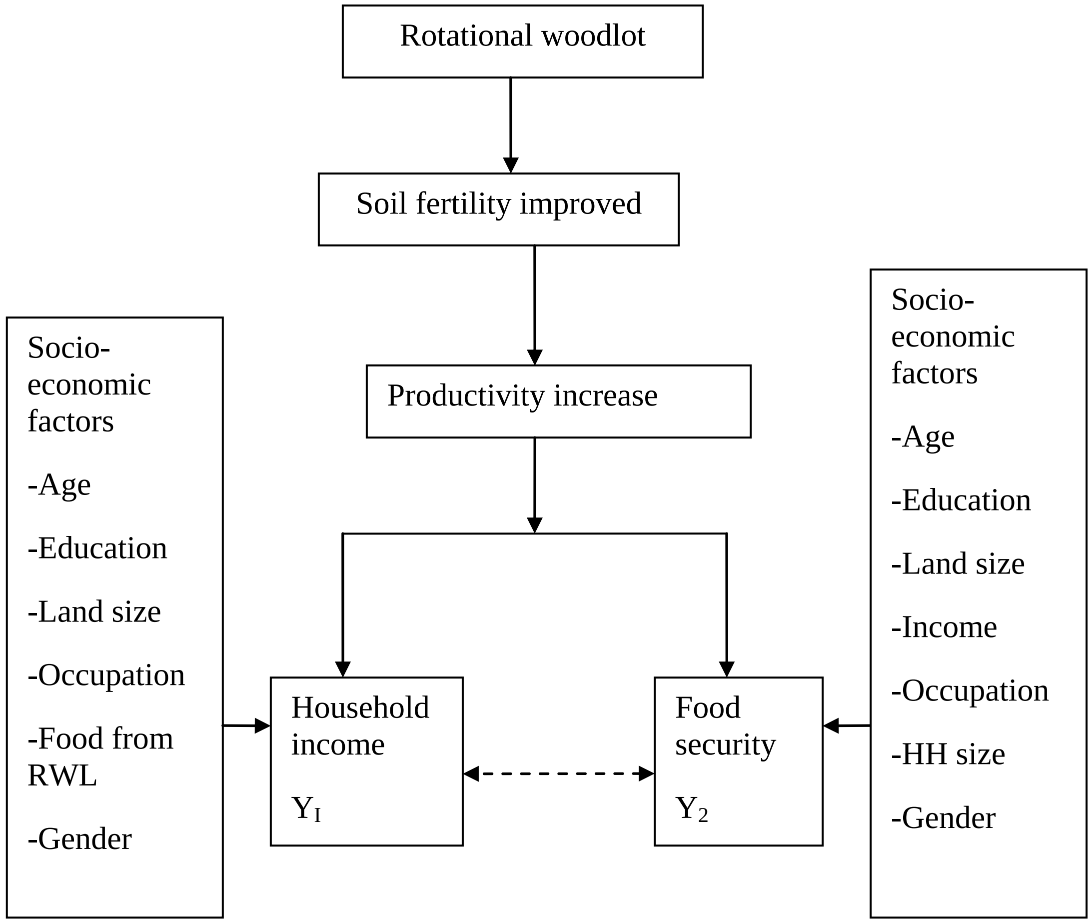

Figure 1: Conceptual frame work which guided the study

1.6 Limitation of the Study

A lot of time was spent visiting households in the pastoral communities due to the fact that the households are scattered and they are agropastoralists. In most cases, daily work schedule had to be re- adjusted to suit their time schedules.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definitions of Terms and the Concept of Agroforestry

Agroforestry is a collective name for land use systems and practices in which wood perennials are deliberately combined on the same land management unit with herbaceous crops or animals either in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economical interactions among different components (Elevitch and Wilkinson, 2003; Lulandala, 2004). Leakey (1996) refers agroforestry as a “dynamic, ecologically based natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users.

Broadly, agroforestry is the combination of silviculture, agriculture, and other land use technologies such that their joint application increases productivity, sustainability, equity, and achieve social goals. Whereas agroforestry systems are defined based on how the various agroforestry components are arranged on the landscape, agroforestry practices are the specific ways the various agroforestry systems are being operated on landscape at a particular time (Lulandala, 2004). Agroforestry provides goods and services to the farmers. The main service roles include soil conservation, creation of favorable microclimate, and social benefits through a multitude of traditional roles that trees play in many civilizations. There are several products from multipurpose trees, and these can be used for subsistence or income generation, for helping farmers to diversify production and reducing risks (Torquebiau, 1992).

As Kaimowitz (2003) argues, agroforestry systems contribute important forest resources for the livelihood of rural communities in some countries in southern Africa; Koimowitz (ibid) emphasizes the importance of maintaining biodiversity, land use conservation and maintenance of agro-biodiversity. In Tanzania as in other Southern African countries, there is an inextricable link between forest resources and livelihoods of the rural communities.

More than 80% of the rural population in sub-Saharan Africa is poor and traditionally relies on forests for most of their livelihood needs including fuel wood and timber as well as other non- timber forest products. Agroforestry ensures better life for the rural communities through provision of food, fruits, medicinal use from such species as *Azaderactica indica*, and *Leucaena* for cattle feeds, and building material (Brigham *et al.*, 1996; Schreckenberg *et al.*, 2006; Ngulube, 2000; Shalli, 2003).

So far, Agroforestry is the only known land management system that effectively integrates the mainly dynamic sectors of agriculture, forestry and animal husbandry in ensuring better use of limited land, labour and time resources. It facilitates the enhancement and diversification in land unit resource production system and permits interactive resource conservation, improvement and sustainability (Lulandala, 2004). Agroforestry is the only resource management option with real tangible opportunity of breaking the bondage of energy, income and food insecurity, and nutritional imbalance among rural communities in developing world (Lulandala, 2004). It has also been reported that forest products provide income for regular household’s expenditure when farmers run out of agricultural crops (Kajembe *et al.*, 2004).

Tanzania decided to implement agroforestry with the aim of developing and accelerating agroforestry technologies, building a network of partners in agroforestry development and improving the marketing of agroforestry products and services. Among the agroforestry technologies developed include rotational woodlot, hedgerows, home gardens, improved fallow, fodder banks and improved indigenous land use (*Ngitili*) (Otsyina and Asenga, 1994).

2.2 Agroforestry in Africa

ICRAF has worked with numerous partners to develop agroforestry innovations that address global challenges of poverty, land degradation, climate change and loss of biodiversity (ICRAF, 2006). The emergence of Agroforestry can be traced as far back as the 1980s, especially in Southern Africa where it started in 1987. Through ICRAF, the agroforestry program later extended into other parts of the continent such as Malawi, Zambia, Tanzania, Zimbabwe in 1989, and Mozambique in 2001 (Oduol *at el.,* 2004). The Ministry of Agriculture Food Security and Cooperatives (MAFSC) and the Ministry of Natural Resources and Tourism of Tanzania (MNRT) do collaborate with ICRAF in promoting the use of agroforestry innovations with the aim of increasing food security, environmental resilience and improved income, especially to small scale farmers.

2.3 Classification of Agroforestry Systems

A variety of agroforestry systems are used around the world, and they can be classified into a number of categories depending on the criteria employed. Agroforestry classifications based on the type of components involved are: silvopastoral systems (production of livestock and woody plant species), agrosilvicultural systems (woody plant species and seasonal plants) and agrosilvopastoral systems (production of livestock, woody plant species and seasonal plants) (Baets *et al*., 2007).

Agroforestry systems can also be classified on the basis of their primary function. Thus, all agroforestry systems have the capacity to provide a range of products and services simultaneously, aiming at producing goods and multifunctional systems, which combine the production of timber and non-timber products with environmental, social and land use services (Beats *et al*., 2007).

Agroforestry systems can be categorized on structural, functional, socio- economic and ecological basis (ICRAF, 2002). In this study, agroforestry systems are classified on functional and ecological basis. Functional basis refers to major functions or roles of the system, usually furnished by woody components which can be of a service or protection in nature like soil conservation, soil improvement, wind protection windbreak, fodder bank and shelterbelt among others. Ecological basis refers to the environmental condition and ecological suitability of systems based on the assumption that certain types of systems can be more appropriate for certain ecological conditions; whether for arid and semi- arid lands, tropical highlands or lowland humid tropics among others.

2.3.1 The rotational woodlot system

This is an improved agroforestry system which is developed with a primarily purpose of increasing fuel wood production as well as improving soil fertility (Kwesiga *et al*., 2003). Rotational woodlot system involve growing trees with crops for two to three years until the trees start competing with the crops (Buyinza *et al.*, 2008).

Trees and crops are grown on farms in three inter-related phases namely tree establishment phase, whereby trees are intercropped with crops. This phase lasts for two to three years. The second phase is a two year fallow with minimum management, and livestock can be allowed to graze on vegetation in the woodlot.

In the third phase after harvesting trees, crops are grown between tree stumps to exploit accumulated nutrients in the litter fall, leaves and branches. The coppiced shoots may be pruned to reduce competition during the second cropping phase and incorporated in the soil or taken as fodder. However the coppiced shoots may be allowed to grow for another cycle of tree fallow phase (Nyadzi *et al*., 2003). The financial analysis carried out in Tanzania by Otsyina and Mumba (2004), shows that over a cycle of five years period RWL are profitable than conventional maize fallow system. In Meatu where land is readily available and land degradation is severe, RWL were preferred as they have multifunctional benefits to users and increase ground cover, thus minimizes land degradation, and ensures sustainability of crop production and improvement of the environment in the agropastroral society.

2.3.2 Improved fallows

This refers to agroforestry technology that involves purposeful planting of fast-growing trees, shrubs, and herbaceous species in rotation with crops for rapid replenishment of soil fertility (Matata *et al.,* 2008). Improved fallows are natural vegetation fallow systems whereby land is deliberately abandoned for some time to allow for regeneration of trees either as coppices or from seeds (Kabwe, 2010). In Zambia, improved fallows are a deliberately planted crop of fast-growing leguminous nitrogen-fixing woody trees or shrubs left to grow on a field for a minimum of two years for rapid replenishment of soil fertility (Böhringer, 2002).

Also some of the improved fallow species have been reported to have the ability to coppice and continue providing nutrient resources to subsequent crops over a longer time while others need replanting once the residual effects start to diminish (Kwesiga *et al*., 2003). On the other hand, natural fallow is land resting from cultivation, usually used for grazing or left to natural vegetation for a long period to restore soil fertility lost from growing crops (Amadalo, 2003). This system evolved as a solution to declining soil fertility caused by shortened fallow periods in shifting cultivation (Kimaro, 2009). Improved fallow technology is a sustainable agroforestry system with the potentials of improving food security, and is being promoted in most parts of Tanzania.

2.3.3 "Ngitili"

This is the traditional Sukuma silvopastral system found in Shinyanga region. The system enhances the availability of fodder, wood products and environment conservation at local level, reducing the soil temperatures water losses and attracting birds which add nutrients to the soil through their droppings (Kaale *et al*., 2002). Traditional *Ngitili* reserves have a greater potential of improving the ecology of the place whereby trees, grass and herbs grow together. They protect the land from soil erosion; facilitate water infiltration and percolation, as they reduce surface runoff thereby increasing soil water storage in the ground. *Ngitili* has the ability to produce dry season fodder, supply fuel wood and improve soil fertility (Kaale *et al*., 2002).

2.3.4 Hedge rows

This is a land use technology whereby ridges and bunds are created in different heights and intervals, across or along contours on which woody perennial are planted (Lulandala, 2004). This puts emphasis on control of soil erosion, and soil conservation while increasing overall productivity of the soil. On contour strips of faster growing nitrogen fixing trees like *Alnus spp* are planted as hedges.

2.3.5 Home garden

Home garden is a land use system practised around the households. It involves integration of various woody perennials, herbaceous crops and or livestock. Multipurpose trees (MTPs) are often used in this system. This system is the famous tree-crop-livestock practice of land use, combining agriculture, forestry, and livestock. The overall return from a unit of land can be increased by intercropping with legumes which enrich the soil through nitrogen fixation, enhancing microclimate amelioration through the reduction of temperatures and evaporation and sheltering the management unit from wind (Huxley and Ranasing, 1996). Similar system is reported to be in use in Senegal and in Bukoba Tanzania (Rugalema *et al.*, 1994)

2.3.6 Fodder bank

This is a plot of trees planted and intensively managed such that the trees are cut continuously for feeding livestock (Böhringer, 2002b). Suitable species include *Acacia angustissima, Calliandra calothyrsus, Gliricidia sepium, Leucaena diversifolia, Leucaena esculenta, Leucaena pallida and Leucaena leucocephala.* Fodder banks are usually best planted close to the place where animals are kept to reduce the amount of labour required for carrying the fodder (Böhringer, 2002).

2.3.7 Biomass transfer

This system refers to mulching or green-leaf manuring using trees or shrub foliage which are cut and applied to the cropping field (Kwesiga *et al.*, 2003). Biomass in a form of leafy and tender twigs is cut and transferred from the area where the leguminous trees are grown to the garden or crop field; and it is incorporated to improve soil fertility (Katanga *et al*., 2007).

2.3.8 Shelterbelts and windbreaks

This system, together with riparian forest buffers, are the main multifunctional agroforestry systems found in Quebec. Windbreaks are narrow plantings of trees and shrubs, mainly tall woody species that form a linear barrier perpendicular to the prevailing winds; they protect cropland, pastureland, roads, farm buildings and houses from the harmful effects of wind and wind-blown sand and dust (Baets *et al*., 2007).

2.4 Contribution of Rotational Woodlots to Household Livelihood

Rural communities in Southern Africa get a wide variety of products and services from RWL to meet their basic needs for food security, health and nutrition through collection of food, medicines, fuel wood and pole (Shackleton and Shackleton, 2000). The harvesting of RWL products is widely recognized as an integral component of the rural livelihoods throughout the developing world, offering goods and services for both household consumption and income generation as products and services derived from agroforestry technologies (Kaimowitz, 2003). Tree planting in crop land has increased crop production and also resulted in the improvement of degraded lands. This addresses specific human and environmental needs, for replenishing soil fertility, fuel wood supply, source of income, food security, soil improvement, source of medicinal plants and land conservation, and enhancing the preservation of indigenous plant genetic materials (Ajay *et al.,* 2008).

2.4.1 Fuel wood supply

Tanzania, like other African countries, is currently facing severe shortages of fuel wood primarily due to increasing human and livestock populations and production of crops using little or no external inputs (FAO, 2003). In Meatu district, fuel wood supply, especially in dry seasons, is one of the problems facing farmers. The establishment of

RWL reduces the pressure on indigenous forests by alternatively providing fuel wood to the rural communities. Over the last two decades, RWLs, as a means of improving fuel wood supply to rural communities and households, have become popular among development agencies in Tanzania (Jacovelli and Caenvalho, 1999).

2.4.2 Income

Fuel wood collection and selling among others, represents a source of cash income for many households in the local communities (Chidumayo, 2002). Women are the principal collectors and consumers of firewood for domestic use, and they are also highly selective in the species used (Clarke *et al*., 1996). It has been reported that in Shinyanga fuel wood is collected by women mainly during dry season in the form of head loads though occasionally men also collect fuel wood using ox-carts. Fuel wood scarcity has led to fuel wood commercialization, especially in village centers and in towns. The fuel wood business in the form of selling charcoal and fire wood has contributed to house hold income (Otsyina *et al*., 1998).

2.4.3 Soil improvement

Trees have the potential to improve soil fertility and soil structure through nutrients contributed as a result of the decomposition of biomass or leaf residues. Fast-growing trees provide products and services such as vegetative cover to reduce soil erosion and facilitate water infiltration and percolation by reducing surface run off and improved water storage (Nyadzi *et al*., 2003). Therefore, farmers who establish rotational woodlots are able to benefit from the fertilized soil, through improved crop production obtained from tree harvests (Ramadhani *et al.,* 2002). Crops grown between tree stumps exploit accumulated nutrients in the litter fall, leaves and branches. Furthermore; Nair (1993) indicates that rotational woodlots reduce the use of inputs and increase labour efficiency.

2.4.4 Food security

Food Security means access by all people at all times to enough food for an active, healthy life (Beckford *et al.,* 2011). In other words, food security is the access to food in terms of being adequate in quantity and quality for meeting all the nutritional requirements of a household throughout the year (Kajembe *et al.,* 2000).

Food insecurity and low income among Tanzanians have persisted mainly due to low productivity caused by several limiting factors which include among others, dominance of inappropriate technologies in crop production and processing, land degradation, low soil fertility, difficulties in accessing land and improved farming inputs and poor crop management practices (Myaka *et al.,* 2003; Kashuliza *et al.,* 2002).

Crop production in Sukuma land is characterized by traditional farming in which soil conservation was not sufficiently addressed. Cultivation leads to an increase of land pressure resulting from population increase and overgrazing; all of which have led to a change of cultivation systems to short fallow periods. RWL has contributed to increased crop production due to its potential for soil improvement through adding soil nutrients and soil conservation (Ssekabembe, 2003).

2.4.5 Land conservation

The RWL contribute to soil conservation and soil fertility that result into an increase in yields of the associated food crops, reduction of cost of farming inputs, increased labour efficiency, creation of a favorable microclimate, and societal benefits through the multitude of traditional roles that trees play (Rocheleau *et al.,* 1988; Kaimowitz, 2003; Kwesiga *et al.,* 2003). For example, in rural communities throughout Africa, medicinal plants constitute a fundamental component of traditional healthcare systems (Gari, 2002) and hence a source of income to traditional healers. Other tree species are used in agriculture in rural areas as pesticides, which lead to reduced costs of agricultural inputs (Magembe *et al.,* 1998).

2.5 Socio-economic Factors Underlying Performance of Rotational Woodlot

2.5.1 Socio-economic factors

Socio-economic factors are important as they influence the performance of RWL and successes or failure of the livelihoods of the local communities (Pradhan, 2006). These include age, sex, source of labour, size of household, income from rotational woodlot, and income from other sources apart from rotational woodlot, land size, education level, size of land under rotational woodlot, occupation, and the size of land under crop production. Selected socio-economic factors are discussed in the following section:

2.5.1.1 Age

Age of the respondent influences wealth and decision making which have an effect on the production capacity of an individual. The age of a person is usually a factor that can explain the level of production and efficiency (Basnayake and Gunaratne, 2002).

2.5.1.2 Sex

Sex is the culturally and socially constructed roles, responsibilities, privileges' relations and expectations of women and men, boys and girls. Because these are socially constructed, they can change overtime and vary from one place to another (Fernandez, 1994). Differences in gender may influence the feasibility of practicing RWL. In many rural communities in Tanzania women have no access to land ownership and ability to purchase land is highly limited due to lack of financial resources. This reflects the traditional bias against women in inheriting some resources such as land (Adesina *et al*., 2000).

2.5.1.3 Household size

A household is defined as a group of people who eat from a common pot, share a dwelling house and have a unit of command from the head of household, who is the main decision maker (Poate and Daplin, 1998). A large household size implies more mouths to feed and more people to share household budget. Population increase has made some rural families have less land to establish RWL and crop production leading to less food (Mafupa, 2005).

2.5.1.4 Education level

Education is one of the strong determinants of household income and food security and has a bearing on household income; level of education is considered as an important factor in natural resource utilization (Maro, 1995).

2.5.1.5 Household income

Low-income in the household contributes to increased dependency on natural resources. Tanzania being one of the world's poorest countries with an estimated 65% of her population living on less than US$ 0.5 per day (Msuya *et al*., 2004), indigenous forest and woodland foods have played a role in poverty alleviation through their big contribution to food security (Kajembe *et al.,* 2000). Reliance on indigenous forest products for food depends on the degree of poverty in the society. A study conducted by Hamza *et al*. (2004), revealed that about 94% of the population using plant medicines had income levels below TAS 200 000 per year.

2.5.1.6 Land size

Land size is an important factor that determines the adoption and the extent of practicing RWL. Farmers with enough land size are more likely to practice RWL than those with small land sizes. Katani (1999) reports that, the number of tree planting increase with an increase of the land size. Farmers with enough land tend to retain trees more in their farms than those depending on hiring the land (Bakengesa, 2002; Rurai;2007). Similarly, it was statistically proven that land size was among the most significant factors in the adoption of agroforestry technologies in Musoma, Tanzania (James, 2004).

2.5.1.7 Land ownership

Land ownership pattern has been noted to be among the fundamental challenges that hinder dissemination and adoption of agroforestry technologies (MNRT, 2003; Msuya *et al.*, 2006). Insecurity on land tenure and inheritance rights was found to result to low adoption of RWL by farmers in Shinyanga Tanzania (Bakengesa *et al*., 2002). Also it was reported that in some areas of Southeast Asia land ownership was not clear, thus causing serious conflicts that discourage the planting of long term tree species (Guzman, 1999). Agroforestry practices, in particular RWLs are a function of farmer land ownership; farmer with access to land are able to practice RWL than those who do not (Bakengesa *et al*., 2002).

2.5.1.8 Technical know how

Lack of proper knowledge on agroforestry technologies is one of the factors that hinder farmers from adopting RWL. According to the study done in Shinyanga, 60 % of farmers were not able to undertake proper management of RWL trial without technical assistance (Hilda, 1997). As Franzel and Scherr, (2000) reported, a successful diffusion and adoption of agroforestry technology depend on performance of those practices that are suitable in the farming systems, extension policy and research support strategies. Farmer empowered with knowledge and skills on agroforestry technologies are able to adopt, improve, and implement these strategies effectively (Msikula, 2003).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of Study Area

3.1.1 Location

Meatu district is located in Simiyu Region, former Shinyanga Region. Meatu District lies between latitude 2º57’ and 4º9’ south of equator and longitude 34º 8’ and 34º 49’ east of Greenwich (Meatu DED,2010). The district is divided into 3 divisions. The divisions are subdivided in 19 wards and 100 villages. The district has a total of 8835km^2 (Fig. 2). The study was conducted in 4 villages, namely Mwambegwa, Bomani, Bulyashi, and Mwamishali.

3.1.2 Climate

The climate of Meatu District can be classified as arid, semi- arid and sub humid with rainfall distribution ranging from 400mm up to 900mm per year, and annual temperature ranging between19^{0}C-24.9^{0}C and the mean annual temperature of 22.7^{0}C. The district has an altitude ranging between 1190 and 1202 meters above mean sea level (Otsyina and Asenga, 1994). The rate of evapotranspiration exceeds the monthly rainfall, thus resulting in serious moisture deficits throughout the year especially on the upland soils. The rainfall pattern is bimodal with most rains in the month of November to December and March to early May (Getahum, 1992).

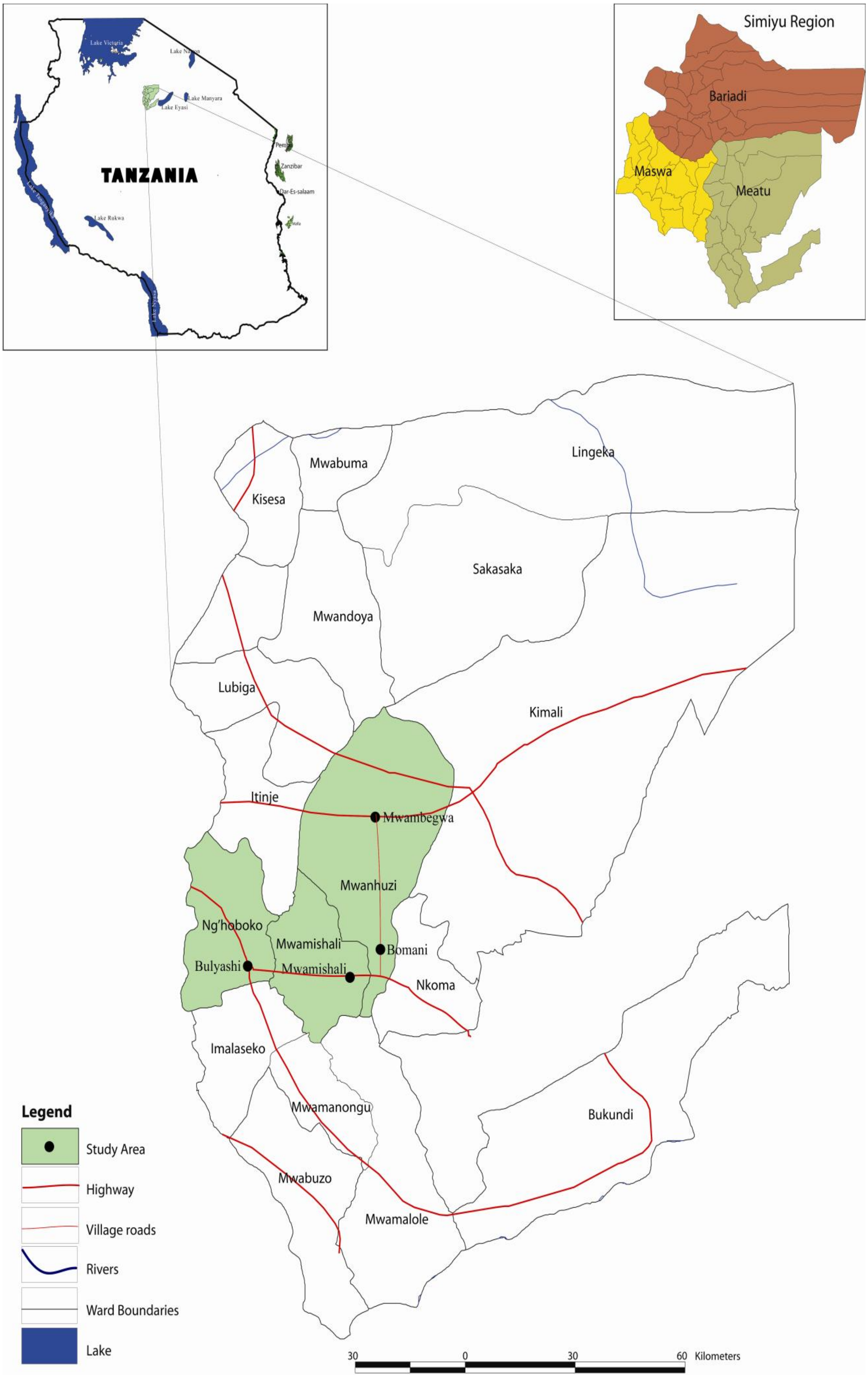

Figure 2: Map of Meatu District

3.1.3 Soils

Meatu soils are poor in fertility and severely degraded as compared to the soils in other district of Simiyu (Otsyina, 1993). The most dominant soil type is black cotton soil; in the lowland area. Black cotton soil is a mixture of clay and silt characterized by cracks during dry seasons locally known as mbuga soil (*vertisols*). Other soil types found in the district mainly range from red to yellowish and drained freely known as *latisols, cambisols ferric luvisols, Acrisols* and *chromic* according to FAO classification.

3.1.4 Vegetation

The vegetation in most parts of Meatu has gradually converted to an open bush savannah dominated by Acacia species such as *A. tortilis. A. Polycantha, A. nilotica.* The area is dominated by scattered or clustered shrubs, thorns trees, forest woodland, bush land, grassland and mixed natural vegetations Some parts are bare without grass cover (Otsyina, 1993).

3.1.5 Land use

There are two dominant land use systems in Meatu District namely the Sukuma agro pastoral system and Crop production. The Sukuma agro pastoral system, as the name implies, comprises a very important livestock and a significant crop production component. Livestock provides milk and animal products for household consumption also animals perform various social functions such as financial security for individual families (Otsyina *et al.,* 1998). In this regard farmers tend to increase livestock numbers to meet their various needs at the expense of available natural resources (Otsyina *et al.*, 1998).

On the other hand, crop production in the Sukuma land, is characterized by traditional system of shifting cultivation. The system involves long fallow period. Thus as population pressure increases so does the pressure on cultivation and grazing (HASHI–ICRAF, 1998). Major crop grown includes Bulrush millet (*Pennisetum glaucum)* and sorghum (*Sorghum bicolor)*on sandy clay soils, cassava (*Manihot esculenta*), sunflower (*Helianthus annuus*), green gram(Vigna uinguiculata), maize (*Zea mays*) and cotton (*Gossypium hirsutum*) on the fine sandy clay soils on mid-slopes and rice (*Oryza sativa*) on clay soils (Otsyina *et al*., 1998).

3.1.6 Population size and growth

The population of Meatu District is 248 214 people according to 2002 census however 2010 projections indicate that the population is increasing**.** The district has four main ethnic groups namely: Sukuma, Nyiramba, Hadzabe and Taturu. The Sukuma is the dominant ethnic group which occupies a large part of the district. Hadzabe and Taturu are mainly involved in pastoralists, gathering and hunting and practice little crop farming.

3.1.7 Economic activities

The economy of the district revolves around agriculture and livestock keeping. The main crops cultivated include maize, rice, bulrush millet and sorghum, cotton, sunflower and chick peas (Meatu District Council Office, 2010). The Sukuma are agro-pastoralists who combine extensive livestock keeping and crop production. Livestock play an important role both economically and socially in the district. Human settlement is relatively permanent, but the herds are grazed over larger areas in order to secure enough food. Such practices result into land degradation, soil erosion and ecological disaster (Brandstorm, 1985). According to district livestock statistic there is an estimate of an average of 12.7 cows per household (Meatu District Council Office, 2010).

3.2 Research Methods

3.2.1 Research design

The cross–sectional research design was used in data collection whereby data were collected at one point and time (Creswell, 2003). The choice of this method partly was based on its ability to meet the objectives of the study and time.

3.2.2 Sampling method and sample size

Purposive sampling procedure was used to select wards based on the number of years rotational woodlot was practiced. Two wards out of 19 were selected basing on proximity, homogeneity and time. From each ward, two villages were selected randomly and from each village 30 households were selected randomly regardless of the population size (Bailey, 1994). Based on this approach, 120 households were sampled in the target villages (Table 1). A household is the most appropriate unit of measurement when assessing the standard of living (Blackwood and Lynch, 1994).

Table 1: Number of households sampled in Meatu

Village	Total HH(N)	Sample size(n)
Mwamishali	495	30
Mwambegwa	450	30
Bulyashi	639	30
Bomani	495	30
Total	1935	120

3.2.3 Data collection

3.2.3.1 Primary data collection

Primary data were collected directly from households using questionnaires, whereby background information on contribution of RWL to HH income and food security in the study area was collected. The collection of primary data involved a number of activities/phases namely reconnaissance survey, questionnaire administering or HH data survey, key informants interview using a checklist and direct observation.

i) Reconnaissance survey

Prior to the main survey, questionnaires were pre-tested on 6 households in Bulyananga village. The pre- testing facilitated improvement of the questionnaire by removing redundant questions and adding new questions which would contribute to the collection of useful information.

ii) Household questionnaire survey

Through structured and semi structured questionnaire, both closed and open ended questions were employed, in which a total of 120 respondents were interviewed in the study area. The type of data collected included annual HH income from RWL, annual food requirement of the households, annual food produced from RWL, and socio-economic characteristics like age, sex of household head, education level, household size, and land size under RWL among others.

iii) Key informant interviews

A checklist was used to obtain information from Key informants including DALDO, DEO, DPO and VEO. A key informant is an individual who is knowledgeable, accessible and willing to talk about the issues under study (Mbwambo, 2000).

iv) Personal Observation

Direct researcher observations were made. For this study, observation was used to assess the general condition of the established RWL (inventory Appendix 3), the household activities, and households' perceptions toward the contribution of RWL to HH income and food security. Personal observation also helped to highlight as to whether or not there are other systems practiced apart from RWL and what is the interlink between socio-economic factors related to RWL.

3.2.3.2 Secondary data collection

Secondary data were obtained from various documents, related to study. The relevant information was also collected to supplement primary data. Such information came from different sources, that are internet, research papers, journals, and publications from libraries, Sokoine National Agricultural Library (SNAL) in Morogoro, HASHI and ICRAF offices (NAFRAC) in Shinyanga, District Natural Resources Office Meatu and village government records.

3.2.4 Data analysis

Both qualitative and quantitative methods of data analysis were used.

3.2.4.1 Qualitative data analysis

Qualitative data and information from the discussion with key informants were analyzed using content analysis technique. Content analysis is a set of methods of analyzing the symbolic content of communication. According to Stemler (2001), content analysis is a systematic, replicable technique for compressing many words or text into fewer content categories based on explicit rules of coding. It is a technique of making inferences by objectively and systematically identifying specific characteristic of messages. Thus information collected through verbal discussions with key informants is broken down into smallest meaningful units of information. Kajembe and Luoga (1996) reported that content analysis technique helps the researcher in ascertaining values and attitudes of the respondents thereby generating themes and tendencies. Qualitative data results were used along with the output generated from quantitative data (descriptive and inferential statistical analyses) to triangulate and enrich the understanding on the contribution of the RWL to communities' livelihood.

3.2.4.2 Quantitative data analysis

Data from questionnaires were summarized, edited and coded. The coding involved structuring the responses from open and close ended questions and assigning them nominal value for analytical purposes. The collected data were analyzed by using computer data processing software, Statistical Package for Social Science (SPSS). Both descriptive and inferential statistical analyses were applied. Descriptive statistical analysis concentrated on frequencies, percentages, mean, standard deviation, and cross tabulation. Inferential statistical analysis was used to provide an idea about whether the patterns described in the sample were likely to apply in the population from which the sample was taken.

Multiple regression models were used to analyze socio-economic factors underlying performance of RWL. These dependant and independent variables are denoted by `Y' and `X' respectively.

The multiple regression equations developed were given by:

$Y_1= \beta_0 + \beta_1 x_1+\beta_2 x_2 +\beta_3 x_3 +\beta_4 x_4 +\ldots\ldots\ldots\ldots +\beta_n x_n + e$……………………….……………………1

Whereby:

Y_1=Household Income from RWL.

X_1= Age of HH head,

X_2= Sex of HH head,

X_3=Education level,

X_4=Occupation

X_5=Total land size,

X_6=land under RWL,

X_7= Amount of food produced from RWL,

X_8= Household size

X_9=Amount of food produced from others

$Y_2= \beta_0+\beta_1x_1+\beta_2x_2 +\beta_3x_3 +\beta_4x_4 + \ldots + \beta_nx_n+e$ 2

Whereby:

Y_2= Food produced from RWL.

X_1=Age of HH head,

X_2=Sex of HH head, Education level,

X_3=Occupation,

X_4=land size,

X_5=land under RWL,

X_6=Income from RWL,

X_7=Income from others

X_8=Household size

X_9=land owner ship

X_i to X_n = independent variables, (i.e. socio-economic factors)

β_0= a constant showing intercepts for regression equation

β_i to β_n = independent variables coefficient showing marginal effects (positive or negative) of the unit change in the independent variables on the dependent variable.

e = error term

i = 1, 2, 3, 4, 5… n. (where n is the total number of variables)

n= Sample size (Total number of respondents i.e.120 for the purpose of this study)

The regression models were applied to explain the relationship between socio-economic factors, underlying performance of rotational woodlot, on household income and food security as surrogate of livelihood in the study villages. From the above, the variables assumptions included in the regression models are explained below:-

X_1 = Age of household head

Age of respondent in years, was assumed to influence wealth and decision making which have an effect on RWL and the production capacity of an individual. An aged person has the ability of securing land and had the wisdom of conserving it, and hence will have positive effect on performance, assumption coefficient (+). The age of a person is usually a factor that can explain the level of production and efficiency.

X_2=Sex of household head

Sex of the respondent is important as it reflects the traditional biasness in relation to land ownership and rights. Normally household has right to inherit land or trees; in most cases women have no right to inherit land or trees. As reported by Bakengesa *et al*. (2002), this may contribute to less involvement of women to rotational woodlot because they don’t have the right to own land, grow tree or secure land rights. As a result, gender ends up having a negative effect on performance of woodlot because women are the main users of forestry products. The expected coefficient assumption was negative (-).

X_3 = Education level of household head

It is assumed that education is one of the strongest determinants of household income and food security. Education level was assumed to contribute to performance of rotational woodlot system. It was recorded with respect to the number of years that a respondent has spent in schooling. The positive (+) coefficient was assumed.

X_4=Size of household

The household size was assumed to be an important factor in determining the extent to which labour would be available in production and management activities of household for rotational woodlot system. The size of the household also helped in estimating food requirements for the household per year and the income required for sustaining the household. A household refers to a group of people who eat and dwell together under same household head The expected sign of the regression coefficient was positive (+).

X_5=Land size (in ha)

The bigger the size of land owned, the more the space would be available for rotational woodlot, and tree planting by the household. It was assumed that, size of the land will determine the extent to which rotational woodlot is practiced. The expected regression coefficient was positive (+).

X_6=Area under rotational woodlot

The bigger the area under rotational woodlot system, the larger the harvest and the yields under good climatic conditions; It was assumed that an increase in the area under rotational woodlot will lead to an increase in the production, when other factors are held constant and expected regression coefficient was positives (+).

$X_{7=}$income of household from RWL per year

It was assumed that the income earned from RWL in a household has an implication on the household income; the expected regression coefficient was positive (+).

X_8= Household income from other source

Household income is a complex issue; the estimates based on the amount of crops harvested from rotational woodlot, and the amount received from other sources, helped to understand the contribution of rotational woodlot system to the household income. Thus, it was hypothesized that having other sources of income such as, livestock, excess food crop produced and cash crop, earning from wages, house rent, remittances and loans,; all these contribute to household income and food security in the community. Regression coefficient was positive (+).

X_9= Land under crop production

It was assumed that, if land under crop production is large there will be more crop harvests under good climatic condition. The regression coefficient was positives (+)

X_{10}= Food obtained from RWL

Understanding of the amount of food earned from rotational woodlot system will motivate farmers into practicing rotational woodlot. The implication of this is that more food earnings have a greater potential to household food security. This assumption may make more farmers practice rotational woodlot. The expected regression coefficient was positive (+).

X_{11}= Food obtained from other source

The household obtains food from different sources; understanding these sources and its contribution is very important as it helps the household head to judge and compare the contribution of rotational woodlot system to the household food security. This means that the difference will influence a larger number of households into practicing rotational woodlot system. It was assumed that regression coefficient was positive (+).

The coefficient of determination (R^2) was used to tell how much variations in the dependent variable were explained by the independent variables; and assessing the strength of the regression model. R^2 is the percentage of the variance in the dependent variables explained uniquely or jointly by the independent variables (Greene, 2000). It can also be interpreted as the proportionate reduction in an error in estimating the dependent variables when the independent variables are known (Gujarati, 1995).The higher the value of the coefficient of determination (R^2) the stronger the model and vice versa.

The dependent variables Y_1 and Y_2

The performance of socio-economic factors that influence RWL based income and food productions were measured by looking at a number of independent variables. RWL based income Y_1 had the following independent variables Age, Sex, education level of household head, occupation, land ownership, land under RWL in acres, food produced from RWL and Household size. The independent variables for RWL Based food production Y_2 were: Age, Sex, education level of household head, occupation, land ownership, land under RWL in acres, house hold size, income from RWL, source of labour and income from other sources. In decision making as shown in Table 5 and 8 probability level was used to document if the independent variable is significant or not.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Contribution of Rotational Woodlot on Household Income and Food Production as Surrogate of Households Livelihood

4.1.1 Contribution of RWL based household income

The results on contribution of RWL based household income to household livelihood in Meatu district are presented in Tables 2. In aggregate, households earn 44.4% of their annual income from RWL and 55.6% from other economic activities. A comparison of various economic activities show that RWL is leading in terms of income generation, followed by sale of crops from plot other than RWL (24.8%), livestock sales (15.6%) whereas, employment, casual/labour and remittance accounted for (15.2%) of the total annual income. RWL provides considerable benefits which farmers apparently obtain,' and these include; fuel wood, building materials, and local herbs (leaf, back and roots). Other benefits include increased harvests of food crops for home consumption and for income generation. This finding is consistent with the findings reported by Bonifasi (2004) and Msikila (2003), which showed that differences in income contribution was observed among farmers practising agroforestry systems.

Table 2: Mean household annual income in (TAS) and percentage contributed from different sources

Sources	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total N	%
RWL	5 395 766.67	374 714.28	1 440 000.00	2 528 000.00	9 738 480.95	44.4
Crop sales	1 877 385.18	1 407 200.00	1 318 793.10	841 166.67	5 444 544.95	24.8
Livestock sales	982 941.18	330 000.00	1 148 000.00	959 583.33	3 420 524.51	15.6
Employment	555 960.00	245 851.85	1 010 583.33	372 882.35	2 185 277.53	9.9
Labour/casual	196 066.67	159 500.00	144 400.00	143 428.57	643 395.24	2.9
Remittance	5000.00	285 000.00	145 000.00	83 333.33	518 333.33	2.4
Grand Total N					21 950 556.51	100

Also it was observed that, respondents managed to maintain communal RWL (Plate 1). Communal woodlots are managed by a group of farmers who practice rotational woodlot system. There are three different communal woodlots in the study area namely *Hashi magharibi, mashariki and Bomani*. Farmers reported that they generate income from the selling of thatch grasses, firewood, and fees from animal grazing. Apart from RWL, other Agroforestry systems that were observed in Mwamishali village which contribute to household income, that is *Ngitili*, Improved fallow and Hedge rows (Plates 2 to 5).

Plate 1: Grazing on communal rotational woodlot fallow in Meatu

Plate 2: *Ngitili* at Mwamishali village

Plate 3: Improved fallow at Mwamishali village

Hedgerows are grown for the purpose of protecting heavy wind to the crops and animals around homestead as Plate 4 and 5 shows.

Plate 4: Hedge rows to protect crops from livestock.

Plate 5: Hedge row for windbreak

4.1.2 Contribution of RWL to household food security

The results show that in aggregate 62.0% of the total food produced in a household is from RWL and 38.0% from other sources (Table 3). The food crops grown include maize (*Zea mays*), Sorghum (*Sorghum bicolor)*, Sweet potatoes *(ipomea batatas)*, Green gram (*Vigna unguiculata*), and groundnuts (*Arachis villosulicarpa*). The relatively higher percent obtained from RWL, is attributed to improved soil nutrients, and soil conservation that consequently contributed to increased food production in the study area. The study done by Ssekabembe (2003) shows that, RWL has contributed to increased crop production due to its potential for soil improvement through adding soil nutrients and soil conservation.

Table 3: Mean Food production from RWL and from non RWL in terms of 90kg of bags

Source	Non RWL	Percentage	RWL	Percentage
Zea mays	44.22	24.9	73.88	25.4
Vigna unguiculata	14.08	7.9	14.00	4.8
Ipomea batatas	57.11	32.2	62.33	21.4
Arachis villosulicarpa	20.92	11.7	48.50	16.7
Sorghum bicolor	41.30	23.3	92.31	31.7
Total (n)	177.63	100	291.02	100
Total food from all sources (N)	**468.65**	**38.0**	**468.65**	**62.0**

The study results show that *Sorghum bicolor, Zea mays* and *Ipomea batatas* have higher mean percentages of food produced, followed by *Arachis villosulicarpa* and *Vigna unguiculata*. High percentage is obtained in *Sorghum bicolor* Zea *mays* and *Ipomea batatas* altributed to the fact that these are the main staple foods in the study area (Table 3). *Arachis villosulicarpa* and *Vigna unguiculata* are used at household and sometimes sold as a source of income. *Sorghum bicolor, Ipomea batatas* and *Zea mays* intercropped with *Arachis villosulicarpa* are planted in woodlot as shown in Plate 6 and 7.

Plate 6: A field of *Sorghum bicolor* and ***Ipomea batatas***

Plate 7: A woodlot plot intercropped with *Zea mays* and *Arachis villosulicarpa*

The study conducted in Imo state Nigeria reported that, trees and shrubs make valuable contributions to the food and income needs of the farming communities, contributing as much as 36.4% of the family food requirement and as much as 43.6% of the total family income (Paulinus, 1999).

4.1.3 Other economic activities contributing to HH income and food security in the study area

The estimation of important economic activities generating income and food seculity at household level apart from RWL was done. whereby crop production, Livestock keeping, Employement and Off-farm activities were recorded to be undertaken at household level (Table 4).

Table 4: Other economic activities contributing to income and food security at household level

Sources	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
Crop/livestock	27 (22.5)	29 (24.2)	27 (22.5)	27 (22.5)	110 (91.7)
Self employed	1 (.8)	1 (.8)	3 (2.5)	2 (1.7)	7 (5.8)
Employment	1 (.8)	0 (.0)	0 (.0)	1 (.8)	2 (1.7)
Off- farm activities	1 (.8)	0 (.0)	0 (.0)	0 (.0)	1 (.8)
Total N	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

(Number in brackets is percentage and outside frequency)

Crop production and livestock keeping was a major contributor after RWL in the study area; about 91.7% of the 120 household were engaged in crop and livestock keeping as other source of income and food security. The crops grown are: *Zea mays*, *Sorghum bicolor*, *Pennisetum glaucum*, *Vigna uinguiculata*, *ipomea batatas*, *Oryza sativa*, *Gossypium hirsutum*, *Helianthus annuus*, and *Arachis villosulicarpa*, 5.8% are self employed, 1.7% are employed (working for wages) whereby 0.8% were engaged in of-farm activities including (running small shops, selling foods) as a copping strategy to income and food supplement to household. Livestock kept in the district include cattle, goats, sheep and donkeys; this implies that most farmers are agropastrolists, that is, they grow crops and keep animals. Cotton and sunflower are grown to generate income; other crops are grown for consumption at the household level. Similarly, livestock products such as milk and meat were consumed at household level and some were sold to generate household income

4.1.4 Households practising RWL in the study area

In the study area, rotational woodlot started to be practiced in 1962 by one person, out of the 120 household interviewed, 0.8%. This could be attributed to some local knowledge which the person inherited from his/her parent's research data 2011, (Fig. 3). The percentage of farmers practising RWL increased slowly - from 2.5% between 1973 and 1983 up to 72.5% in 1994-2004 which shows that more farmers started practising rotational woodlot after HASH/ICRAF initiated agroforestry research in Lubaga village, Shinyanga urban and Meatu districts. From 2005 the percentage decreased to 24.2% to date (Fig. 3). This sharp decline of household practising RWL is perhaps attributed by lack of close supervision and monitoring of established woodlots by HASHI/ICRAF, inadequacy of extension services due to resignations and transfer of some village extension staffs, Land shortage resulting into most RWL farms to be converted into pure stands of annual crops such as *Zea mays*, *Sorghum bicolor* and *Gossypium hirsutum*, *Helianthus* Plate 8 and 9.

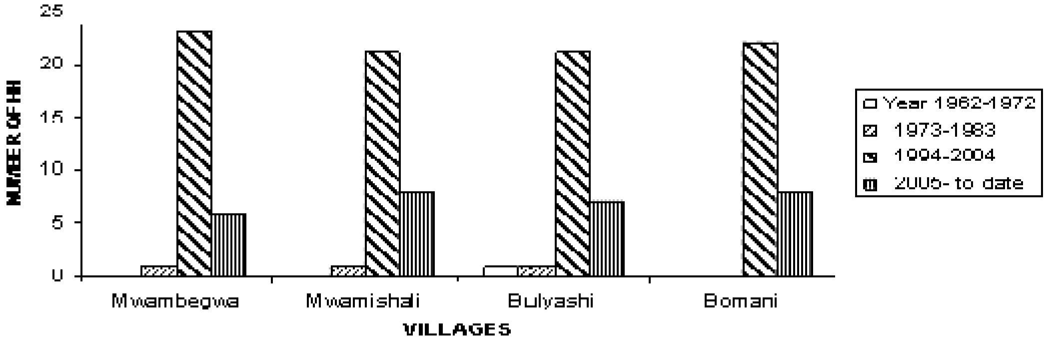

Figure 3: Households practising RWL

Plate 8: Maize field converted from RWL

Plate 9: A cotton crop in woodlot field

4.2 Socio-economic Factors Underlying Performance of RWL based HH Income

Regression model results revealed that, there are socio-economic factors that enhance the performernce of RWLs based household income (age of household head, landownership, and total food produced from RWL) and those that constrain the performance of Rotational woodlot to Household income (sex of household head, education level, occupation, land under RWL, household size, and total food produced from RWL) as indicated in Table 5. The model explained about 98% (R^2 =0.984) of the variation in the factors underlying performance of RWL in term of income and food produced from RWL (Appendix 4).

Table 5: Regression analysis of socio-economic factors influencing household income from RWL

Variables	Beta	Std. Error	t	Sig
(Constant)		3.97	1.18	0.239
Sex	-0.04	1.21	-3.11	0.002**
Age	0.03	0.04	1.83	0.071Ns
Education level	-0.00	0.65	-0.16	0.871Ns
Occupation	-0.01	0.70	-0.42	0.675Ns
Land ownership	0.01	0.01	0.58	0.563Ns
Land under RWL in (ha)	-0.01	0.04	-0.32	0.747Ns
Total food produced from RWL	0.99	0.01	43.64	0.000***
House Hold size	-0.02	0.44	-1.22	0.224Ns
Total food per house per year	-0.03	0.00	-2.21	0.029*

Key: * significant at p value = ≤ 0.05, Ns =Not significant at 0.05 level, R^2= .984 Correlation

4.2.1 Socio-economic factors enhancing performance of RWL based Income

4.2.1.1 Age of household head

Table 5 shows that age of the household was positively correlated to RWL based household income but not statistically significant (p> 0.05). This implies that increasing age by one unit could enhance performance of RWL in terms of income. A plausible explanation is that the elderly person in the community has the ability to influence decision making which has contribution to HH income. This implies that age of the respondent increases the respondents' chances of trying different or alternative sources of household income, also age influence creativity, elderly people are more creative than young ones and might have experienced in taking care of their families which enabled them to cope with existing situation. However, the study done by Mazuimavi (2009) showed that age was not an important factor in deciding what to practice in Zimbabwe in conservation farming in agriculture systems by vulnerable household.

4.2.1.2 Land ownership

Table 5 shows that Land owned by a household was positively correlated to income obtained from RWL, but not statistically significant ($p>0.05$). Despite the fact that land ownership is not statistically significant, the results suggest and not show because they were not statistically significant that land ownership enhances the performance of RWL based household income. RWL involves tree planting which is along term investment requiring secure and long term tenure right. This implies that household that own land, practice RWL and generate more income for household needs. Land ownership is a typical characteristic which is required in order to practice RWL. Therefore farmers who do not own land could not plant trees on hired land. The report by Guzman (1999) shows that some areas of Southeast Asia, land ownership was not a clear cut matter, thus causing serious conflict which discourages long term investments including tree planting.

4.2.1.3 Food produced from RWL

Table 5 show that food produced from RWL was positively correlated with RWL based household income and statistically significant ($p<0.05$).This means that an increase in food production from RWL by a unit enhances HH income. This suggests that the increase of household income from RWL could attract RWL practice in the household. The survey and analysis of the income and expenditure done by Aliber (2009) in South

Africa shows that poor rural households spend a larger share of their total expenditure on food. In this study it was found that most households spent more on food.

4.2.2 Factors constraining performance of RWL based HH Income

4.2.2.1 Sex

Table 5 shows that sex of the respondent was statistically significant ($p<0.05$) but was negatively correlated to RWL based household income. This means that participation of women in RWL by a unit could decrease the performance of RWL based household income. Plausible explanation is that access to land, ownership, weak tenure right and lack of education contributed to women poor participation hence negative correction to performance of RWL.

4.2.2.2 Education

Table 5 shows that education levels of the respondents was found to be negatively correlated to RWL based income but not statistically significant ($p>0.05$) level. This means that increasing the number of years spent in formal education by one factor constrain the performance of RWL based household income. The plausible explanation is that lack of extension services to household head leads to poor knowledge on RWL and they face more challenges in practising RWL and its management. Also they consider it to yield less compared to their mono crop and that is too traditional for them to practice. This implies that education on RWL is required to household head that contributes to awareness, willingness and readiness to participate RWL at HH level. Therefore lack of extension service may lead to poor technology dissemination, regardless of formal education attained. Table 6 shows that the majority of the respondent about 84.2% had attained primary education and 7.5% have no formal education.

Table 6: Level of education

	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
No formal education	2(1.7)	1(.8)	3(2.5)	3(2.5)	9(7.5)
Adult education	0(.0)	0(.0)	0(.0)	1(.8)	1(.8)
Primary education	25(20.8)	26(21.7)	24(20.0)	26(21.7)	101(84.2)
Secondary education	1(.8)	3(2.5)	3(2.5)	0(.0)	7(5.8)
Tertiary education	2(1.7)	0(.0)	0(.0)	0(.0)	2(1.7)
Total N(120)	30(25.0)	30(25.0)	30(25.0)	30(25.0)	120(100.0)

Number in brackets indicate percentages where as number outside indicate frequency

4.2.2.3 Land under RWL

Table 5 shows that land under RWL was negatively correlated with RWL based household income obtained from RWL but not statistically significant at $p>0.05$ level. This can be attributed to the constraint mentioned by the respondents who had small farm sizes and those who borrowed land. These farmers thought that planting trees on their farms could lead to a decrease in production of other short-term crops that are most important for their livelihood. This means that, having small farm size, using borrowed and or hired land, constrained the performance of RWL based income. This finding concurred with (Raussen and Wajja-Msukwe, 1998) who reported that due to small land holdings' in the area, it is mostly the wealthy farmers that can afford to allocate land to woodlot.

4.2.2.4 Household size

Table 5 shows that household size was negatively correlated with RWL based income and not statistically significant at ($p>0.05$) level. This means that an increase in the household size by one unit could reduce the RWL based income. The probable explanation is that family size is an important determinant factor of the consumption rate and labour available for production in the household. Increased household size when land and other factors are fixed, increase household labour at a certain level decreases output and productivity.

From the survey results, shows that majority of HH size had 3-5 members 88(73.3) that has highest frequency and percent, followed by 5-7 members 30(25.0) and the lowest was ranging from 1-3 members 2(1.7) which has the lowest frequency and percentage (Table 7). This is supported by a study done in Shinyanga and Meatu whereby most of the respondents indicated that labour was a problem in establishing woodlots, because RWL requires intensive labour in planting and weeding (Ngazi, 1997).

Table 7: Household size

House Hold size	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
1-3	0(.0)	0(.0)	1(.8)	1(.8)	2(1.7)
3-5	21(17.5)	26(21.7)	21(17.5)	20(16.7)	88(73.3)
5-7	9(7.5)	4(3.3)	8(6.7)	9(7.5)	30(25.0)
Total N	30(25.0)	30(25.0)	30(25.0)	30(25.0)	120(100.0)

Numbers in bracket are in percentages and out side frequency

4.3 Socio-economic Factors Underlying Performance of RWL Based Household Food productivity.

Regression model results revealed that socio-economic factors including gender of the household head, occupation of the household head, land under RWL, and income from RWL were enhancing RWL based household food production. However, age, education level and land owned by the household head, were constraining RWL based food production. The R^2 = 0.961, which implies that independent variables explain about 96% variation in the regression equation relationship (Appendix 5).

Table 8: Result of regression analysis of the contribution of socio-economic factors that influence RWL Based food production

Variables	Beta	Std. Error	t	Sig
(Constant)		1467619.92	0.59	0.558
Sex	0.01	433250.43	0.23	0.819Ns
Age	-0.03	11796.21	-1.30	0.197Ns
Education level	-0.04	232238.32	-1.53	0.130Ns
Occupation	0.02	238022.93	1.01	0.316Ns
Land ownership	-0.01	2535.69	-0.45	0.672Ns
land under RWL (ha)	0.13	13654.80	3.17	0.002*
Source of labour	0.01	89295.20	0.66	0.508Ns
Income from RWL	0.64	0.05	17.44	0.000***
Income from other sources	0.32	0.04	11.07	0.000***
House Hold size	0.00	147746.94	0.04	0.972Ns

Key: * Significant at p value ≤ 0.05, Ns =Not significant at 0.05 level, R^2= 0.961Correlation

4.3.1 Socio-economic factors enhancing performance of RWL based food production

4.3.1.1 Sex

Table 9 shows that sex of the respondent was positively correlated with RWL based food production but not statistically significant (p>0.05). This implies sex enhances HH food production in RWL. Has contributed to positive performance of RWL, with respect to food production. Table 9 shows that (89.2%) of the respondents were men practising rotational woodlot where as 10.8% were women. This implies that under normal circumstances women do not own RWL. The reason is that, Sukuma culture restricts women to own land and right to inherit this has contributed to less percentage (10.8) of women practising RWL in study area. This According to Bakengesa *et al*. (2002) in Shinyanga region, point out that Sukuma culture restricts women to inherit and right to own land. This result also concurred with the study done by Shao *et al*. (1992), traditionally for the Wasukuma, it is men who own land, yet married women cannot inherit land.

Table 9: Sex of the household head

Sex	Frequency	Percent
Male	107	89.2
Female	13	10.8
Total	120	100.0

4.3.1.2 Occupation

Table 8 results from regression analysis shows that Occupation of the household head was positively correlated with RWL based food production but not statistically significant (p>0.05). This implies that the presence of other sources of occupation to the household reduces the dependency on RWL as the only source of food in the HH as indicated in Table10. Supplementing RWL food based production. The majority (91.7%) of the interviewed household were engaged in agriculture with (8.3%) of them are self employed and engaged in off-activities.

Table 10: Occupation of household head

Sources	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
Agricultural	27 (22.5)	29 (24.2)	27 (22.5)	27 (22.5)	110 (91.7)
Employment	1 (.8)	0 (.0)	0 (.0)	1 (.8)	2 (1.7)
Self employed	1 (.8)	1 (.8)	3 (2.5)	2 (1.7)	7 (5.8)
Off- farm activities	1 (.8)	0 (.0)	0 (.0)	0 (.0)	1 (.8)
Total N(120)	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

Numbers in bracket are in percent and, outside frequency.

4.3.1.3 Land under RWL

Land under RWL was positively correlated with RWL based food production and was statistically significant ($p<0.05$). This implies that a large size of the land under RWL enhances RWL food production. A plausible explanation is that having enough area for cultivation as indicated in Table 11 shows that 84 household out of 120 (70%) in study area land owned range from 0-50 ha can have bearing a household with smaller farms cultivated short term crops for subsistence, thereby paying little attention on tree planting. Similar results were reported by Katani (1999) who reveals that the number of trees planted increases with an increase in the farm size.

Table 11: Land owned by households (in ha)

Size (in ha)	**Mwambegwa**	**Mwamishali**	**Bulyashi**	**Bomani**	**Total**
0-50	19 (15.8)	23 (19.2)	20 (16.7)	22 (18.3)	84 (70.0)
51-100	6 (5.0)	5 (4.2)	4 (3.3)	2 (1.7)	17 (14.2)
101-150	3 (2.5)	1 (.8)	1 (.8)	3 (2.5)	8 (6.7)
151-200	1 (.8)	1 (.8)	1 (.8)	2 (1.7)	5 (4.2)
201 and above	1 (.8)	0 (.0)	4 (3.3)	1 (.8)	6 (5.0)
Total	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

Numbers in bracket are in percent and, outside frequencies.

4.3.1.4 Income from RWL

Table 8 shows that income from RWL has positive correlation to RWL based food production and statistically significantly ($p<0.05$). This implies that, an increase in income from RWL has a greater potential to household food production hence food security, and that the household with income practice RWL based food production, although household with higher income had a better chance to practice RWL based food production than those with low income. The result in Table 12 shows that 37.7% of the total HH in study area obtains income less than 50 000 TAS from RWL, while 63.3% of the total HH receive above 51 000 TAS. This result concurred with result reported by Kashuliza *et al*. (2002), Myaka *et al*. (2003) and Sicilima (2003) indicate that agroforestry contribute to food security and household income.

Table 12: RWL Based Household Income.

Income (in TAS)	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
<50 000	12 (10.5)	9 (7.9)	11(9.6)	11(9.6)	43 (37.7)
51 000-100 000	4 (3.5)	8 (7.0)	3(2.6)	1(0.9)	16 (14.0)
101 000-150 000	4 (3.5)	2 (1.8)	2 (1.8)	0 (.0)	8 (7.4)
151 000-200 000	1 (0.9)	2 (1.8)	2 (1.8)	2 (1.8)	7 (6.1)
200 000>	9 (7.9)	8 (7.0)	12 (10.0)	11 (9.6)	40 (35.1)
Total	30 (26.3)	29 (25.5)	30 (25.8)	25 (21.9)	114 (99.9)

Numbers in bracket are in percent and, outside frequency.

4.3.1.5 Income from other sources

The income from other sources was positively correlated to RWL based food production and statistically significant ($p<0.05$). This implying that there other sources that contributes to household food security. On the other hand, it can be noted that availability of other economic activities has substantial contribution and significant implication on household food security. This result concurred with Hamza *et al. (*2004), revealed that about 94% of the income of communities living around miombo woodlands of Nachingwea is contributed from medicinal plants.

4.3.1.6 Household size

Table 8 shows that household size has a positive correlation with the performance of RWL based food production, but not statistically significant (p>0.05). This means that, an increase in the household by one unit could increase RWL based food production. The household size is an important factor in determining the household labour availability, consumption rate and amount of food required per household. The existence of farm activities demand more labour for crop production, tree planting and management of HH farm (Table 7). This implies that the families with larger household size are able to practice RWL based food production. The results are comparable with the study done in Shinyanga urban and Meatu district indicate that labour was a problem in establishing woodlots, planting and weeding (Ngazi, 1997). This is in line with other studies done in Eastern Usambara by Kajembe and Mwaseba (1994) showed that labour is a constraint to rural household activities during rainy season which often coincides with other family socio- economic activities. The observation in this study conforms to this augment. Therefore increasing HH is important.

4.3.2 Socio-economic Factors constraining performance of RWL based HH Food Production

4.3.2.1 Age

Table 8 shows that age of the respondent was negatively correlated with RWL based food production but not statistically significant (p>0.05). This implies that the respondent’s age is inversely proportional to the performance of RWL with regard to food production. Table13 shows that (86.7%) of respondents in the study area are in the age range of 18-60 years old which are productive group, (12.5%) over 60 years (unproductive group), while under 18 years unproductive group were (0.8%). The age of a person is usually a factor that can explain the level of production and efficiency. Age of respondent influences wealth and decision making which have an effect on the production capacity of an individual (Basnayake and Gunaratne, 2002).

Table 13: Age of respondent

Age	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
< 18 yrs	1(.8)	0(.0)	0(.0)	0(.0)	1(.8)
18-60 yrs	25(20.8)	30(25.0)	23(19.2)	26(21.7)	104(86.7)
> 60 yrs	4(3.3)	0(.0)	7(5.8)	4(3.3)	15(12.5)
Total	30(25.0)	30(25.0)	30(25.0)	30(25.0)	120(100.0)

Number in brackets indicate percentages where as number outside indicate respondents

4.3.2.2 Education level

Education level of the respondent was found to be negatively correlated with the RWL based household food production but not statistically significant (p>0.05). This means that increasing the number of years spent in formal education constrain performance of RWL based food production (Table 6). The plausible explanation is that, the high rate of literacy of household head in the study area has no direct influence on RWL based household food productivity, because it does not need any formal education to practice RWL. Education level considered as important factor in natural resource utilization (Maro, 1995). As a result, in the study area some of the established RWL do not exist and others have been encroached in *Bulyananga*, *Bomani* and some parts of *Mabambasi Magharibi* (Appendix 3). This shows that RWL based food production is negatively correlated with education level of household head.

This finding is in line with other similar observation in Bakengesa (2001) who noted negative correlation between education level and tree planting in Shinyanga rural and urban area. It also imparts the desire of an individual to learn more, to attend training and seek information regarding interventions (Luhasi, 1998).

4.3.2.3 Land ownership

Table 8 shows that land ownership was negatively correlated with RWL based household food production and not statistically significant ($p>0.05$). Land ownership is an important factor in determining the practice of RWL. Those who don't own land could not plant trees on hired land. The analysis done by Kessy and O'kiting'ati (1994) shows that land ownership had a negative correlation with household food production. Hence practising RWL increased with increasing landownership status.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study revealed that rotational woodlot contributes 44.4 % of the total household income and 62.0 % of the total food produced in the study area. However during 2005 to date RWL is in a sharp decline (figure 3). Majority of the respondents were engaged in agriculture with crop production and livestock keeping having the highest percentage (91.7) with regard to livelihood activities. The products and services obtained by household from RWL include: firewood, charcoal, construction materials, local herbs, fodder and pasture, soil improvement and high yield per unit area.

The study also identified a number of Socio-economic factors that enhance and constrain performance of RWL based household income. Those enhancing performance of RWL include; age of the household head, land ownership, the total food production from woodlots while those constraining performance of RWL based household income were sex of household head, education level of household head, land under rotation woodlot and household size.

Other socio-economic factors were for either to enhance or constrain performance of RWL based household food productivity. The factors that enhanced RWL were; sex of household head, occupation, land under RWL, income from RWL, income from other sources and household size. The age of household head, Education level of household head and land ownership were constrained to RWL based household food production. The study concluded that rotational woodlots have positive effects on household livelihoods both on HH income and food productivity, so need to be promoted.

5.2 Recommendations

Based on the findings, the following are pertinent recommendation.

(a) The need to establish tree nurseries in the villages practising RWL

Tree nurseries that will provide seedlings in the villages practising rotational woodlots need to be established since some of the woodlots are sparsely located. I would recommend tree species of A*zadiarachta Indica, Leucaena Leucocephala, Senna Siamea, Acacia Polycantha, Zanha Africana* and *Entada Abyssinica* as requested by respondent.

(b) The need to recruit more extension staff in the villages

There is a need to recruit more village extension staff that will impart knowledge on RWL management and help to create community awareness through seminars, workshops, and study tours to enhance community capability.

(c) The importance of conducting frequent monitoring and evaluation

For the purpose of sustainable contribution of RWL to community livelihood, frequent monitoring and evaluation of rotational woodlots established should be done. This will serve in the improvement of rotational woodlots and act as a guide in the preparation of management plans which are important for sustainable contribution of Rotational woodlot in the study area.

(d) The need to take into consideration socio-economic factors underlying perfomernce of RWL

The socio-economic factors that enhance or constrain performance of rotational woodlots should be put into consideration in the management of RWL. These are likely to lead to improved household income and food production and thereby more involvement in practising rotational woodlots.

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APPENDICES

Appendix 1: Questionnaire for heads of household's survey

A. Farm household characteristics

Questionnaire number: …………………….……Date: …………………… …………

1. Interviewer's Name……………………………………………………....
2. District…………..Division…………..Ward…......................Village…......
3. Farmer's name……………………………………………………………
4. Farmer's age…………………………………...………………………

B. Household Composition

1. Household members and their attributes

Name	Gender	Age	Education level	Marital status	House hold head	Occupation
1.						
2.						
3.						
4.						
5.						

Key to question B

Sex	Marital status	Household head	Main occupation	Education level
Male	Married	Adult male	Crop production	1.No formal education
Female	Never married	Adult female	Livestock keeping	2. Adult education
	Widower	Orphan male	Salaried employment	3. Primary education
	Widow	Orphan female	Self-employed off-farm	4. Primary education
	Divorced		Casual labour on/ off-farm	5. Secondary education
	Separated		Student/pupil	6. Tetiary education
	Too young to be married		Non school child	7. Non school child

C. Rotational woodlot Information

8. When did you start to practice rotational woodlot? ....

9. Why did you choose to engage in this RWL? ………………………………..…

i). Is more profitable……………………………………………………………..

ii). Government advice……………………………………………………..……

iii). Persuaded by neighbors......... …………………………………………………

iv) Enough land………………………………………………………..………

v). For feeding livestock…………………………………………………………

vi). For land improvement……………………………………………………….

vii) Others ……………………………………………………………..………

10. Apart from rotational woodlot system, what other systems do you practicing in your household?

i)………………………………………………………………….………………

ii)…………………………………………………………………………………

iii)…………………………………………………………………………………

11. The total size of land owned by the household? (Acres)

12. What size of land under rotational woodlot system? (Acres)

13. How is land owned in your village?

a) Private……………………………………………………………………………

b) Communal…………………………………………………………………………

c) Other specify……………………………………………………………………

14. How was the land obtained by household?

i) Inherited

ii) Bought

iii) Given by village government

iv) Accessed free land

v) Hired

15. Who makes most of the decision on land in this house hold?

Please indicate the following responsibility by gender

Responsibility	Men	Women	Both
Land preparation			
Planting			
Weeding			
Harvesting			
Storage			
Marketing			
Decision on the use of sales			

16. Source of labour available

i) Family members ………………………………………………...………………

ii) Hired labour…………………………………………………………………...…..

iii) Both1and 2 above…………………………………………...………………

iv) Working group……………………………………………………………………

17.Do you have conflict over land use in this area...?

D. Household's Income.

18. How much income do you earn per household per year.......................................?

19. How much money do you earn from rotational woodlot per household per year?

Source of income	Amount TAS	Amount requiredTAS
Income from rotational woodlot		
Income from other source e.g. Crop sale		
Livestock sales		
Remittance		
Labor/casual		
/employment etc		
Others (specify)		
Total		

21. During the year /season do you critically in need of cash for agricultural and household related activities/expenditure.?

i) Yes…………………………………….

ii) No…………………………………….

22. If yes how do you overcome it (explain) …………………………………………..

23. Contribution of off-farm activities to annual household income?

Off-farm activities	Estimated annual income (TAS)
Carpentry	
Local brew	
Petty business	
Casual labour	
Salary	
Assistance from relatives	
Loans	
Rents (house, equipment, tools)	
Pension	
Beekeeping	
Firewood selling	
Charcoal making and selling	
Others (specify)	

E. Household's Food security.

24. How much food do you need per household per year? (Kgs).......................................

25. How much food do you earn from rotational woodlot per household per year? (Kgs)

26. How much food do you earn from other sources? (kgs)……………………….………...

Source of food	Amount produced (bags)/kg	Amount required (bags)
Crop produced from rotational woodlot		
Crops produced from other source apart from rotation woodlot system:		
1.		
2.		
3.		
4.		
Total		

27. Do you experience food shortage in your household?

i) Yes…………………

ii) No……………

28. If you're house hold got food shortage how did you cope with it?

Strategies used to cope with food shortage	1= Yes, 2= No	Explanation
Borrowing food		
Working for food		
Selling households' assets, fire wood, building poles		
Getting food aid from relatives		
Getting food aid from the government		
Searching for wild foodstuffs and eating them or selling it		
Eating fewer meals per day		
Borrowing cash for buying food		
Doing casual labor work to get cash to buy food		
Temporary migration of some household members		
Temporary migration of all household members		
Getting food aid from neighbors		
Selling livestock		
Soliciting remittances from relatives living in town		

Appendix 2: Checklist for key informants' interview

Name of respondent--

Region --

District--

Division------------------Ward---------------------Village----------------------------------

Date of Interview-----/-----/---

Village population--

Number of households in the village---

Major food and cash crops grown in the village?

Food crops--

Cash crops--

4. Is any extension worker in your area of governance----------------------------------?

5. What is his/her main activity or activities--?

6. There any Government involvement in agroforestry activities in this village?

----

7. What type of involvement? --

8. Are there any nongovernmental organizations involved in rotational woodlot system? -- --

9. Who were the target group in the village as far as rotational woodlot system? ----------- ---

10. What are the use or benefits did you get from rotational woodlot system? --------------- --

11. In your views what do you think are the main causes of not practicing rotational woodlot system in your area? --

12. Does the villages have any bylaw to protect rotational woodlot established? ------

13. If yes, what does it advocate---

14. How do you rate its implementation and effectiveness-------------------------------

15 what are management objectives of rotational woodlot system? ---------------------

16. Is there any committee in the ward/village governed rotational woodlot? ----------

17. What is your recommendation for the success of rotational woodlot system practiced in this area? --

18. Is the number of people practicing rotational woodlot system increasing or decreasing over time? --

19. If the number is decreasing what are the factors underlying the decrease? ---------

Rotational Woodlot Status Inventory Form

Date--

Village----------------------------Ward---

Date established-------------, Area---

General condition to date-----------------------------, Area ----------------------------------

s/no	Location name	Date established	Area(ha)	General condition to date	Area(ha) to date	Remarks/status

Appendix 3: Available rotational woodlots and their status

Division: Kimali

Ward: Mwanhuzi

Location name Village	Date Established	Area(ha)	Status to date	Area(ha)to date	Management regime/Remarks
Ushirika	2000	4	Good	4	Plan to increase the area
Bulyanshimba	2002	20		7	
Imaramakoye	2003	160	Good	160	Privet owner plan to process title deed
Mwanzagamba migongwa	2006	200	Good	200	Privet owner, plan to process title deed
Mabambasi Hashi	1987/89	79	good	79	Owned by group
Mabambasi maghalibi Hashi	1987/89	200	Good	200	Owned by group

Appendix 4: Regression result 1: RWL based income

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.992(a)	0.984	0.982	3.81127	.984	731.964	9	110	0.000

Analysis of variance

		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	95690.966	9	10632.330	731.964	0.000(a)
	Residual	1597.834	110	14.526		
	Total	97288.800	119			

	Variables	B	Std. Error	Beta	t	Sig
1	(Constant)	4.70	3.97		1.18	0.239
	Gender	-3.78	1.21	-0.04	-3.11	0.002S
	Age	0.06	0.04	0.03	1.83	0.071S
	Education level	-0.11	0.65	-0.00	-0.16	0.871NS
	Occupation	-0.29	0.70	-0.01	-0.421	0.675NS
	Total land owned (in ha)	0.00	0.01	0.01	0.58	0.563NS
	Land under RWL in (ha)	-0.01	0.04	-0.01	-0.32	0.747NS
	Total food produced from RWL	0.50	0.01	0.99	43.64	0.000S
	House Hold size	-0.54	0.44	-0.02	-1.22	0.224NS
	Total food per house per year	-0.00	0.00	-0.03	-2.21	0.029S

Key: * significant at p value = ≤ 0.05, Ns =Not significant at 0.05 level, R^2= .984 Correlation

Appendix 5: Regression result 2: RWL based food production

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.980(a)	.961	.957	1265856.42456	.961	269.045	10	109	.000

Analysis of variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4311161787470322.000	10	431116178747032.200	269.053	.000(a)
	Residual	174660781148926.400	109	1602392487604.829		
	Total	4485822568619249.000	119			

Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig**
(Constant)	862769.75	1467619.92		0.59	0.558
Gender	99145.68	433250.43	0.01	0.23	0.819NS
Age	-15317.21	11796.21	-0.03	-1.30	0.197NS
Education level	-354346.36	232238.32	-0.04	-1.53	0.130NS
Occupation	239677.98	238022.93	0.02	1.01	0.316NS
Land owned (in ha)	-1076.69	2535.69	-0.01	-0.43	0.672NS
land under RWL (ha)	43340.53	13654.81	0.13	3.17	0.002S
Source of labour	59335.90	89295.20	0.01	0.66	0.508NS
Income from RWL	0.842	0.05	0.64	17.44	0.000S
Income from others	0.468	0.04	0.32	11.07	0.000S
House Hold size	5199.62	147746.945	0.01	0.04	0.972NS

Key: * significant at p value = ≤ 0.05, Ns =Not significant at 0.05 level, R^2= .0.961Correlation

Appendix 6: Land owned by households (in ha)

Size (in ha)	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
0-50	19 (15.8)	23 (19.2)	20 (16.7)	22 (18.3)	84 (70.0)
51-100	6 (5.0)	5 (4.2)	4 (3.3)	2 (1.7)	17 (14.2)
101-150	3 (2.5)	1 (.8)	1 (.8)	3 (2.5)	8 (6.7)
151-200	1 (.8)	1 (.8)	1 (.8)	2 (1.7)	5 (4.2)
201 and above	1 (.8)	0 (.0)	4 (3.3)	1 (.8)	6 (5.0)
Total	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

Numbers in bracket are in percent and, outside frequency.

Appendix 7: Occupation of households in Meatu District

Sources	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
Agricultural	27 (22.5)	29 (24.2)	27 (22.5)	27 (22.5)	110 (91.7)
Employment	1 (.8)	0 (.0)	0 (.0)	1 (.8)	2 (1.7)
Self employed	1 (.8)	1 (.8)	3 (2.5)	2 (1.7)	7 (5.8)
Off- farm activities	1 (.8)	0 (.0)	0 (.0)	0 (.0)	1 (.8)
Total	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

Numbers in bracket are in percent and, outside frequency.

Appendix 8: Mean food produced from RWL in Bags of 90kg per HH

Crops	Mwambegwa	Mwamishali	Bulyashi	Bomani	Mean	Percent
Sorghum bicolor	33.7500	22.5000	22.5556	13.5000	92.3056	31.9
zea mays	15.1176	17.9375	25.3889	15.4444	73.8824	25.0
ipomea batatas	15.5000	15.0000	18.5000	13.3333	62.3333	21.5
Arachis villosulicarpa	20.0000	10.0000	10.0000	8.5000	48.5000	16.8
Vigna unguiculata	6.0000	2.0000	6.0000		14.0000	4.8
TOTAL	90.3676	67.4375	82.4445	50.7777	289.0193	100

Appendix 9: Mean food produced from non RWL in Bags of 90kg per HH

Crops	Mwambegwa	Mwamishali	Bulyashi	Bomani	Mean	Percent
Sorghum bicolor	26.7500	6.7500	15.7143	8.0000	57.1173	32.1
Zea mays	10.6042	9.7000	13.4000	10.5208	44.2250	24.9
Ipomea batatas	9.3333	15.0000	8.6667	8.9000	41.3000	23.2
Arachis villosulicarpa	3.7500	3.6667	9.5000	4.0000	20.9167	11.7
Vigna unguiculata	1.7500	9.0833	3.2500		14.0833	7.9
TOTAL	52.1877	44.2000	50.5310	31.4208	177.6423	100

Appendix 10: Constraints to contribution of RWL to HH income and food security

Constraints	Mwambegwa	Mwamishali	Bulyashi	Bomani	Total
	F	F	F	F	F
Land size	5 (12.8)	3 (7.7)	1 (.8)	7 (17.9)	16 (40.2)
Compete with crop	5 (.3)	1 (.8)	1 (.8)	4 (3.3)	11 (2.2)
Lack of knowledge	2 (1.7)	2 (1.7)	4 (3.3)	2 (1.7)	10 (8.4)
So cost to maintain	1 (.8)	2 (1.7)	4 (.0)	3 (.0)	10 (2.5)
Shade to crop	0 (.0)	4 (3.3)	4 (3.4)	0 (.0)	8 (6.7)
Difficult to mgt	4 (4.3)	1 (.8)	1 (.8)	0 (.0)	6 (5.9)
Debarking for herb	2 (1.7)	1 (.8)	2 (1.7)	0 (.0)	4 (4.2)
Theft	1 (.8)	1 (.8)	0 (.0	1 (.8)	3 (2.5)
Reduce yield	1 (.8)	2 (1.7)	0 (.0)	0 (.0)	2 (1.7)
Frequent pruning	1 (.8)	0 (.0)	1 (.8)	0 (.0)	2 (1.7)
Harbour Pest	1 (.8)	0 (.0)	2 (1.7)	0 (.0)	2 (1.5)
Drought	0 (.0)	0 (.0)	0 (.0)	1 (.8)	1 (.8)
Limited Tree see	0 (.0)	0 (.0	1 (.8)	0 (.0)	1 (.8)
None	11 (9.2)	4 (3.3)	8 (6.7)	8 (6.7)	29 (25.9)
Total	30 (25.0)	30 (25.0)	30 (25.0)	30 (25.0)	120(100.0)

(Numbers in bracket are in percent and outside frequency).