

**CONTRIBUTION OF AGROFORESTRY HOMEGARDENS TO HOUSEHOLD  
FOOD SECURITY AND INCOME GENERATION AMONG COMMUNITIES IN  
MBEYA RURAL DISTRICT, TANZANIA**

**BILLES LUKA NZILANO**

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE  
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## ABSTRACT

The present study was conducted in Mbeya Rural District during December 2011 to April 2012 with the main objective of assessing the contribution of Agroforestry homegardens to household food security and income generation among communities. The study involved four randomly selected wards, one village per selected ward and thirty households from each village, all selected randomly. Data collection was done through field surveys using relevant social survey methods. The findings indicate that 99% of the communities in Mbeya Rural District practice Agroforestry Homegardens as one of their main sources of household food security and income generation. Six sources of household food security and income generation were identified in the study area with Agroforestry homegardens and agriculture being the main sources of life sustenance. Of the Agroforestry Homegardens contribution, seventeen percent (17%) is towards household food security and twenty five percent (25%) towards income generation. According to the communities studied, food security and income generation over the year form 78% of the motivating factors to adopt the Agroforestry homegardens. Crop competition, low capital and unreliable markets, were together the main factors (by 77%) which negatively affected the contribution of Agroforestry homegardens to household food security and income generation in the area. Sixty seven percent (67%) of the communities indicated that credit facilities, knowledge on components arrangements and market availability for homegardens products, were the main interventions required in improving the contribution of Agroforestry homegardens adoption. Based on these findings, Agroforestry homegardens is a major source of food and income generation in Mbeya Rural District. Therefore, there is a need for enhancing and reviving further the Agroforestry homegardens technologies for the benefits of the wider communities beyond the District. This should go hand in hand with the provision of sufficient credit facilities, extension services together with marketing arrangements.

**DECLARATION**

I Billes Luka Nzilano, 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 been submitted for a degree award to any other institution.

.....  
Billes Luka Nzilano  
(MSc. Candidate)

.....  
Date

The above declaration is confirmed by

.....  
Prof. P.K.T. Munishi  
(Supervisor)

.....  
Date

.....  
Prof. L.L.L. Lulandala  
(Supervisor)

.....  
Date

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**DEDICATION**

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**ABBREVIATIONS**

ANOVA	Analysis of Variance
COSTECH	Commission of Science and Technology
DALDO	District Agriculture and Livestock Development Officer
DED	District Executive Director
DPLO	District Planning Officer
FAO	Food and Agriculture Organization
GDP	Gross Domestic Products
ICRAF	International Center for Research in Agroforestry
IFAD	International Funds for Agricultural Development
MAFSC	Ministry of Agriculture, Food Security and Co-operatives
MDG	Millennium Developmental Goals
MNRSA	Management of Natural Resources for Sustainable Agriculture
NEP	National Environmental Policy
NGO'S	Non-Governmental Organization
SACCOS	Savings and Credit Cooperative Society
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
sq	square
SUA	Sokoine University of Agriculture
Tshs	Tanzanian shillings
URT	United Republic of Tanzania
VAEO	Village Agricultural Extension Officer
WEO	Ward Executive Officer

## CHAPTER ONE

### 1.0 INTRODUCTION

#### 1.1 Background Information

Homegardens are traditional Agroforestry practices with multiple functions practised by rural farmers around homesteads as a strategy of livelihood diversification to stabilize their sustenance (Das and Das, 2005 ; Ffolliot, 2005; Kebebew *et al.* 2011). Homegardens involve integration of various woody perennials, herbaceous crops and /or livestock on the same unit of land management (Nair, 1993) with the aim of increasing production and income generation (Nair and Kumar, 2004). Homegardens also are among the Agroforestry technologies maintained by rural farmers, fulfilling an important role in the ecological, social and economic function of communities (Nair, 1993).

The main attributes that have been identified from homegardens which contribute to the sustainability of these technologies are biophysical advantages such as efficient nutrient cycling offered by multispecies composition, conservation of bio-cultural diversity, product diversification as well as non-market values of products and services, and social and cultural values including the opportunity for gender equality in managing the technologies (Kumar and Nair, 2004). With their multi-layered vegetation structures, homegardens serve as an important habitat for wild flora and fauna (Kehlenbeck and Maass, 2004; Tangjang and Arunachalam, 2009). Also this Study shows that homegardens are generally regarded as very complex, species-rich Agroforestry systems managed in a sustainable manner over decades or even centuries.

Because of high plant diversity in the homegardens (Kumar and Nair, 2004), a wide spectrum of multiple-use plant products can be generated with relatively low labour, cash or other inputs (Kumar, 2006). In seasons of scarcity homegardens with their diverse products available year round, contribute towards food security (Tynsong and Tiwari, 2010). Homegardens are most commonly planted in blocks, rows (Alley farming), or random arrangements around or adjacent to homesteads and communities (Ffolliott, 1998). Kumar and Nair (2008) reported that tropical homegardens is one of the oldest forms of managed land-use systems and are considered to be epitomes (hearts) of sustainability. They evolved through generations of gradual intensification of cropping in response to increasing human pressure and the corresponding shortage of arable lands.

The contribution of Agroforestry homegardens practices is well appreciated throughout the world (Kebebew *et al.*, 2011). Globally, famine and starvation are knocking with speed. As the world population expands the food problem has become increasingly severe, with the number of those malnourished reaching 3 billion (Olajide Taiwo *et al.*, 2010). During the period of 1993 to 2003 up till now, Africa's rate of population growth has been higher than the rate of food production (Bishaw and Abdelkadir, 2003). Despite the identification of food security as an important policy goal in Africa, too many African countries continue to be food insecure especially among the urban-poor (Olajide Taiwo *et al.*, 2010). This can be reversed through conscious integration of the homegardens strategy into rural and urban development (Krishnal *et al.*, 2012). Homegarden technologies provide an additional food supply and cash income for the people (Das and Das, 2005). For example in Indonesia and Nicaragua, the report showed that homegardens contributed 21.1% and 35% of their total income respectively (Tynsong and Tiwari, 2010). In South-

West Bangladesh and North Eastern Bangladesh, the report showed that an average of 15.9% and 11.8% of household income is derived from Homegardens respectively (Motiur *et al.*, 2005).

In Tanzania, it has been projected that by 2020, Agroforestry technologies have to be adopted in order to contribute to improving the livelihoods of 60% of the country's resource-poor households (Kitalyi *et al.*, 2006). The importance of homegardens as a technology is based on the complexity of interactions between species that occur within Homegardens, and their apparent sustainability over time in order to meet the people's needs in terms of food, fuel wood, livestock products (milk, eggs, meat) fodder, income and building materials. The primary emphasis of homegardens is food production for household consumption (Ndaeyo, 2007; Lulandala, 2010). For a long time Mbeya especially Mbeya rural District has been reported to be among the biggest four regions in the country for food production compared to other regions (Bisanda *et al.*, 1998).

However, recently, there has been a decline in food production trends which resulted in low yields and income earnings to households (URT, 2010). These declines required a strategic plan that will enhance the balancing of the productivity rather than its normality (URT, 1997). Development and introduction of new technologies which increase productivity of labour and land are highly needed to fulfill the people's needs. Integrative and sustainable natural resources management is required to rescue the environment from destruction as well as biodiversity loss (URT, National Environmental policy, 1997). Compared with subsistence agriculture, Homegardens Agroforestry provide added

benefits by generating income from the marketing of diverse products which will sustain the household food supply throughout the year (Fenandes *et al.*, 1984).

## **1.2 Problem Statement and Justification**

Food and household income insecurity are the major concerns today in many parts of Tanzania which are fuelled by the increase in population density (FAO, 1999). High population density has put a lot of pressure on land as more of it is required for settlement (Musotsi *et al.*, 2008). This has led to land fragmentation, which has negatively affected food production, hence, resulting into food insecurity (Kebebew *et al.*, 2011). According to the 2002 census, the population density of Mbeya Rural District was 105 people per square kilometer, while in year 2010 the projection increase was 127.6 people per square kilometer DED (2012). Based on the MDG's goals for poverty alleviation, intensification and diversification of production strategies are of importance to meet the food and land requirement for the increased population.

Complying with the objectives of the National Agricultural Policy (URT, 1997), there must be assurance of basic food security and improvement of national nutritional standards by increasing output, quality and availability of food commodities to all citizens. Land use practices thus have to be intensified to maximize food production on the small land available. Homegardening has been identified as a means of providing all year round access to food for rural households (Kebebew *et al.*, 2011; Kumar, 2006; Akinnifesi *et al.*, 2010) that helped smallholder farmers to support their family (Kalaba *et al.*, 2009). According to Motiur *et al.* (2005) reported that in Bangladesh and India on average, 15.9% and 11.8% of household food and income is derived from Homegardens

respectively. In Africa, Musotsi *et al.* (2008) reported that in Butere Western Kenya; home gardening plays a significant role in food security of rural households with respect to size of land and food stock. Rugalema *et al.* (1992; 1994) in Bukoba district. Tanzania indicated that homegardens productivity declined due to gradual decline of soil fertility which was mainly influenced by various factors in Agroforestry homegarden farming systems. While Fernandes *et al.* (1984) reported that the Chagga homegardens have an advantages claimed from the multi-species, multi-storey home gardens, which include soil conservation, nutrient cycling and efficiency, microclimate enhancement and other benefits such as labour efficiency, risk minimization, and continuous production. The mentioned studies were done in other districts but not in Mbeya Rural District.

From this point of view, in Mbeya Rural District the review of literature clearly shows that there is no known research done on the systematic assessment and documentation of the homegardens potentials and the information to that effect remains fragmented. Therefore, the present research is intended to fill this information gap and provide information on the contribution of Agroforestry homegardens to the livelihoods of the smallholder farmer's households. The findings obtained from this study will be useful in redirecting, improving and strengthening the existing Agroforestry homegardens programmes in Mbeya Rural District and elsewhere in the country.

### **1.3 Research objectives**

#### **1.3.1 Main objective**

The overall objective of this study was to assess contribution of Agroforestry homegardens to household food security and income generation among communities in Mbeya Rural District, Tanzania.



### **1.3.2 Specific objectives**

The specific objectives were

1. To identify the Agroforestry homegardens technologies practised in the study area;
2. To identify and determine the various sources and quantities of household food supply and income generation among communities;
3. To determine the proportion of homegardens technologies contribution to households food security and income generation to smallholder farmers; and
4. To determine the factors influencing the contribution of Agroforestry homegardens technologies to household food production and income generation to smallholder farmers.

### **1.4 Research Questions**

1. What type of Agroforestry homegardens technologies are practised in the study area?
2. What are the sources and quantities of household food and income generation in the study area?
3. What is the proportion of Agroforestry homegardens contribution to household food security and income generation?
4. Which factors influenced the contribution of Agroforestry homegardens to household food security and income generation in the study area?

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Agroforestry homegardens technologies and their existence

Homegardens are widely distributed throughout the world and have been extensively documented (Fernandes *et al.*, 1984). Tanzania has been a home of Agroforestry homegardens for ages since 1970s where they conceived Agroforestry homegardens as a strategy to meet people's needs (Kitalyi *et al.*, 2006). Homegardens have been established in various places in the country for various purposes. For example in Kilimanjaro and Bukoba they were established to cater the land scarcity problems, in Shinyanga (rotational wood lot) for soil conservation and animal feeds etc. Moreover, in Mbeya Rural District, Agroforestry homegardens technologies are well practised although they are not yet recognized nor documented.

The word "homegarden" has been used rather loosely to describe diverse practices, from growing vegetables in the backyard to complex multistoried systems (Nair, 2012). It is used here to refer the intimate association of multipurpose trees and shrubs with annual and perennial crops and invariably livestock within the compounds of individual houses, with the whole crop-tree-animal unit being managed by family labour (Fernandes and Nair, 1986). Homegardens also provide the family with food and other goods, including construction materials, ornaments, or additional income (Kumar and Nair, 2004).

Homegardens represent many Agroforestry characteristics, which imply that the close mix of diversified agricultural crops and multipurpose trees fulfills most of the basic needs of

the local population Maroyi (2009). While the multistoried arrangement and high species diversity of the homegardens help to reduce environmental deterioration commonly associated with monocultural production systems (Nair and Kumar, 2005).

### **2.1.1 Various systems of Agroforestry homegardens**

The concept of Agroforestry homegardens is based on the development of the interface between agriculture and forestry. It is a sustainable multiple-production system whose outputs can be adjusted to local needs. The main components of Agroforestry systems are trees and shrubs, crops, pasture, and livestock together with environmental factors of climate, soil, and landform. Other components (e.g., bees, fish) occur in specialized systems (Young, 1989). Under this definition, a variety of combinations of plants may be possible. Based on these three basic components, Agroforestry homegarden systems can also be classified according to their practical purposes and component composition as reported by Hasanuzzaman (2008); Nair (1989); Hoogerbrugge and Fresco (1993) and Nair (1993) as follows: Agrosilvicultural homegarden system, Silvopastoral homegarden system and Agrosilvopastoral homegarden system.

#### **2.1.1.1 Agrosilvicultural homegarden system**

This is an Agroforestry homegardens system where agronomic crops are combined with trees/shrubs on the same unit of land for higher or better-sustained production of annual crops, fodder, and wood. This system is most practised in lowland sub humid tropics for food production purpose (Nair, 1993). Agroforestry homegarden systems are generally more practised in all areas where crop production is the most dominant economic land use activity for example Rukwa, Ruvuma, and parts of Mbeya, Katavi, Njombe and Iringa

regions. Wider spacing is adopted without sacrificing tree population for easy cultural operation and to get more sunlight to the intercrop. Performance of the tree crops is better in this system when compared to monoculture (Young, 1989).

### **2.1.1.2 Silvopastoral homegardens system**

This is an Agroforestry homegarden system where a range of crops and/or animals and trees are combined for better production of grasses and fodder (Nair, 1993). This combination can be arranged as a pure stand with fodder trees/shrubs planted as a protein bank (with cut-and-carry fodder production) and/or mixed in different configurations such as living fences of fodder trees and hedges. The trees / shrubs and grass components are arranged in such a way that their healthy coexistence is not disrupted. The Acacia-dominated system in the arid parts of Ethiopia, Kenya, and Somalia are good examples of this system (Bishaw and Abdelkadir, 2003).

The Silvopastoral homegarden system can be practised on both range and forest lands for the production of both feed and woody materials. Also the system can be practised on sloping ground by growing grasses and trees/shrubs together for soil conservation purposes (Young, 1989). The main objective of this practice is to supply feed for livestock during the dry season with high quality tree leaves and pods. This substantially increases the productive capacity of poor and scarce pasture lands common on the Hararghe Highlands. Fuelwood and construction poles can also be produced with this system.

### **2.1.1.3 Agrosilvopastoral homegardens system**

This is an Agroforestry homegardens practice by which food, pasture, and tree/shrub crops are combined on the same unit of land for the production of grass and browse feed, biomass for fuel wood and green manure, and food for human consumption (Lulandala, 2011).

The system is practiced when the farmer needs all the benefits that would be obtained from Silvopastoral and Agrosilvicultural technologies from a unit of land (Bishaw and Abdelkadir, 2003; Tolunay, 2008; Bassullu and Tolunay, 2010). Usually such a technology is practised on cultivated land. Alternative rows of hedges, grass strips and/or crops would form such a technology, a form of alley cropping.

Agrosilvopasture homegardens are also practised when the cropland is constrained by slope and threatened by erosion (Nair, 1993). These are very common problems of land use in most of the Ethiopian Highlands; therefore, this system has potential for use in various regions of the country. The practice encompasses many well-known land-use technologies long practised in the Ethiopian Highlands (Abebe, 2005). Thus, it is apparent that Agroforestry is only a new word for an old practice: it is based on forestry, agriculture, animal husbandry, land resource management, and other disciplines that all form the systematic background of land use. Furthermore, it encompasses an awareness of interactions between humans and the environment and between demand and available resources in a given area.

By definition Agroforestry is a collective term for land-use systems involving trees combined with crops and/or animals on the same unit of land. It combines production of multiple outputs with protection of the resource base. According to Bishaw and Abdelkadir (2003), Agroforestry is any sustainable land-use system that maintains or increases total yields by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land, either alternately or at the same time, using management practices that suit the social and cultural characteristics of the local people and the economic and ecological conditions of the area.

### **2.1.2 Benefits of Agroforestry homegardens**

Agroforestry homegardens are common in most tropical countries and they play a vital role in supporting households in many diverse ways, including provision of food, fuel wood, building materials, and fodder for livestock, and income. They are regarded as source of income diversification and also play crucial cultural and social role in rural communities (Fernandes and Nair, 1986; Bonifasi, 2004; Guuroh *et al.*, 2011) defined homegardens as land use practices involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably, livestock, within the compounds of individual houses, the whole crop-tree-animal unit being managed by the family labour. Agroforestry homegardens are primarily used for subsistence purposes by households; they are increasingly being used to generate income (Mendez *et al.*, 2001). The quantity of Agroforestry homegardens production that actually gets sold is highly variable, differing from one household to another. Hoogerbrugge and Fresco (1993) reported that between 9% and 51% of production is sold in Indonesia

## **2.2 Sources of food security for the households**

### **2.2.1 Homegardens**

Is land use technologies practiced around the homesteads, involving the integration of various woody perennials, herbaceous crops and /or animals. Homegardens are often overlooked as an important source of food security and income generation in the world. For subsistence and poor farmers, crop varieties and cultivars adapted to particular micro-niches around homesteads are crucial and accessible resources available to provide a secure livelihood. Gautam *et al.* (2004) reported that in India Agroforestry homegardens contributed 60% of the household's total fruit and vegetable consumption, in Philippines, twenty percentage (20%) of the foods consumed by families are produced in the homegardens whereas in Vietnam 51% of their produce is used by household members Trinh *et al.* (2003).and Marsh (1998) reported that the combined value of garden production, including sales of surplus vegetable produce and animal products combined with savings in food, varied seasonally but constituted a significant proportion of total income upwards of 20% for many.

### **2.2.2 Agriculture**

The majority of Tanzanians depend on agriculture as their main occupation and source of livelihood (URT, 1997; Myaka *et al.*, 2003). Agriculture sector in Tanzania contributes 45% of the GDP, 80% of the employment and 85% of the total export earnings (FAO, 1993; FAO, 1999; Nyoni, 2007). Growing of diverse crops in Agroforestry homegardens has become important source of food security and influences the availability of quality food required by the households.

### **2.2.3 Forestry**

Forestry and trees make a significant source of food security and household income. Forest foods are particularly important in predominantly subsistence economies in remote areas and they have a high potential of supplying food if well managed (FAO, 1996). As pointed out by Tewari (1994) and Makino (2003) that wide variety of forest products including non-timber forest products from diverse tree species for fruits, fodder, foods and firewood provide food security to a large low-income population particularly during periods of drought and works as an insurance against famine and crop failure.

### **2.2.4 Livestock**

Livestock keeping provides people with another important source of household food security by keeping a variety of domestic animals in their homegardens for several uses. Keeping these animals provide employment to rural farmers, food and can provide income (Njuki, 2001).

### **2.2.5 Business (off-farm income generating activities)**

Off-farm income generating activities are those activities apart from farming where people are engaged in to increase their income. The off-farm activities provide secondary sources of earnings for smallholder farmers and landless farmers. Diversification of activities in terms of on farm and off-farm activities contribute to the improvement of household economy (ICRAF, 1996).



### **2.3 Contribution of Agroforestry homegardens to household food security**

In most tropical Agroforestry homegardens, food production is the first function and role. One major aspect of significant role of food production in homegardens is to hold up continuous production throughout the year (FAO, 2004a, b; Kebebew *et al.*, 2011) reported that in Southern Ethiopia 88.8% of the surveyed households were food secured throughout the year. Homegardens also can solve the problem of land scarcity by using a small land the households have by integrating various components in the same piece of land hence food security and income generation (Devendra and Thomas, 2002; Abebe, 2005).

The combination of crops with different production cycles and rhythms results in a relatively uninterrupted supply of food products (Nair, 2012). Depending upon the climate and other environmental characteristics, there may be peak and slack seasons for harvesting the various products, but generally there is something to harvest daily from most homegardens (Nair and Kumar, 2004). Most of this production is for home consumption, but any marketable surplus can provide a safeguard against future crop failures and security for the interval between the harvests (e.g. rice in Java and Sri Lanka, coffee and maize in Tanzania, coconut and rice in southwestern India, and so on). Additionally, these harvesting and maintenance operations require only a relatively small amount of labor from the members of the family (Krishnal *et al.*, 2012). Hence homegardens are among the best solutions of household food security and income generation to smallholder farmers due to their diversity (Kebebew *et al.*, 2011; Lulandala, 2011). This is especially in all areas of the tropics under pressure from increasing populations and unsystematic deforestation.

### **2.3.1 Household food security**

Food security is access to food in terms of being adequate in quantity and quality for meeting all the nutritional requirements of a household from one year to the next and within the year (Kajembe *et al.*, 2000). Beckford *et al.* (2011) reported that food security is a condition where all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. FAO (1996) revealed that many rural households do not have year-round access to adequate amounts of both fresh and processed staple foods and their fresh vegetables and fruits tend to be seasonal. As food being the central to well-being of any living creature, there must be food security constituted by one of the indices of measuring poverty level. A household or individual who spends over 70% of one's total income on food is said to be poor and food insecure. Therefore, food security is of paramount importance (Ndaeyo, 2007).

### **2.3.2 Homegardens to income generation**

Homegardens can contribute to household income in several ways. Income from homegardens comes from selling cereal crops, fruits, vegetables and other cash crops (e.g., lime, *rambutan*, jackfruits, *durian*, cloves, and coffee) to local brokers or merchants (Christanty *et al.*, 1986; Marsh, 1998). In many cases, sales of products produced in homegardens significantly improve the family's financial status. For example in West Java, as much as two-thirds of the homegardens production is reported to be sold (Jensen, 1993a; Wilson, 1995), while in South African homegardens only 28% of such products were sold, the remainder being used for household consumption (High and Shackleton, 2000). In Indonesia and Nicaragua homegardens contributed 21.1% and 35% of their total

income respectively (Tynsong and Tiwari, 2010). In South-West Bangladesh and North Eastern Bangladesh, an average of 15.9% and 11.8% of household income is derived from homegardens respectively (Motiur *et al.*, 2005). Hence generally, homegardens play a great role in income generation as compared with other sources as it uses multiple components that produce diverse products. In this study it is aimed to assess the Agroforestry homegardens contribution to household food security and income generation in Mbeya Rural District which is unknown

### **2.3.3 Households food insecurity**

Food insecurity exists when members of a household have inadequate diet for part or throughout the year or face the possibility of inadequate diet in the future. Food insecurity is of two types; chronic food insecurity and transitory food insecurity (Nyange, 2000). Chronic food insecurity occurs when there is persistent lack of households ability to buy or produce enough food, which can be attributed to persistent drought (Shilabu, 2008). While transitory food insecurity is a temporarily decline in household access to enough food due to instability in food production and prices or household income and health conditions (FAO, 1996).

### **2.3.4 Coping strategies to household food insecurity**

Various reasons like continuous cultivation of open lands result into land degradation and consequently, poor crop production. This decreased harvest leads to inadequate food for the households. Thus farmers look for alternatives to rehabilitate their farms' poor biophysical conditions, as well as augment production. Macandog *et al.* (2003) reported that in order to cope with food insecurity, farmers resort to integrate trees, crops and

livestock in the farm, homegardens and backyard farming for their livelihood sustenance. However, in Mbeya rural communities their coping strategies are not yet known.

## **2.4 Factors affecting contribution of Agroforestry homegardens to household food security**

The contribution of Agroforestry homegardens to household food security and income generation has been affected by different factors including the homegardens productivity, shortage of irrigation water, incidence of pests and diseases, markets and lack of extension services as reported by Mariro (2009).

### **2.4.1 Homegardens productivity**

Homegardens productivity is an essential aspect to be viewed out of homegardens fertility (Nair, 1993). High fertility results into high crop productivity as well as high quality livestock fodder resulting into healthier animals. The fertility of Agroforestry homegardens, which are usually more intensively cropped than other field systems is usually maintained with farmyard or pen manure, household manure, kitchen waste, compost, crop residues and sometimes toilet waste (Jensen, 1993b; Thorne and Tanner, 2002; Hailu, 2008). The productivity of homegardens is constrained by factors like drought and loss of fertility that are attributed by deforestation which lead to serious erosion especially along river banks and steep slopes. Homegardens Agroforestry as composite systems has the potential for increasing land use intensity while maintaining the productivity of the natural resources base. It enables the land to support much higher population densities than the traditional agriculture (Hailu, 2008).

#### **2.4.2 Homegardens and livelihoods**

Agroforestry homegardens plays a vital role in contributing to peoples livelihoods. Maroyi (2009) and Guuroh *et al.* (2011) reported that Agroforestry homegardens improves the family's nutritional status, health, and food security. Agroforestry homegardens therefore, is part of a household livelihood strategy and has gained prominence as a natural asset through which sustainable use of resources, particularly for the livelihoods of the poor, may be achieved. Homestead gardening and Agroforestry systems provide an important contribution to sustainable agricultural production because of their potential to meet economic, social, ecological, and institutional conditions for sustainable livelihoods (Nair, 2006).

#### **2.4.3 Shortage of irrigation water**

Water is a basic natural resource required to sustain life and provide various social needs as well as for economic development (URT, 2002). Many parts in Tanzania depend on rain fed agriculture resulting into crop failure and hence household food insecurity. Water resource is of importance for food production not only because of its direct effects on yields and the size of cultivated area, but also reliable water supplies induce farmers to invest in other essential crop inputs, such as improved germplasm, fertilizers, and capacity building for better resource management (Rosegrant, 1997).

#### **2.4.4 Incidences of pests and diseases**

In some African countries, pests' impacts have been estimated on average of about 30% of the total subsistence production loss annually (Makundi, 1996). In Tanzania, a shortfall in crop production especially cereal productions close to or around this figure threatens food

security of practically the entire Nation. Pests and diseases together with low agricultural input supply are the major cause of production declines which lead to household food insecurity (SUA, 2006).

#### **2.4.5 Lack of extension services**

Lack of agriculture extension services to farmers lead to poor knowledge of farming practices that leads to low yields, hence food insecurity. Moreover, majority of rural people depend on the surplus farm produce that they sell to get income for other needs. Therefore, failure of farm produce may lead to low income earnings. Agricultural extension service has been defined as the transfer of agricultural technology from experts (including progressive farmers) to farmers, livestock keepers and other stakeholders (URT, 1997). While experts are the link between the farmer,/ livestock keepers and research where agricultural technologies are developed, tested and modified. The research extension – farmer/ livestock keeper linkage also provides a framework for planning research and extension activities, developing new technologies arising from research and extension experts, and from indigenous knowledge (URT, 1997). Therefore lack of linkages between research extension and farmers/livestock keepers may lead to poor farmers/livestock keepers' problem solving and technologies dissemination (Tesha, 1996).

#### **2.4.6 Lack of credit facilities and reliable markets**

Availability and accessible credit facilities to farmers enhance production improvement by easily accessing the required inputs at right times (Mrindoko, 2012). Majority of smallholder farmers depend on farm products to get their food and incomes. Unreliable markets of their produce lead them to sell their produces by farm gate prices. These

resulted into low earnings and food insecurity (IFAD, 2012). Empowerment of farmers through credit provision will improve their production status as well as their well beings as reported by Smale *et al.* (2009) who reported that empowered farmers through provision of agricultural inputs, upgraded the staple food production in Washington DC. Also Doward *et al.* (2008) reported that provision of subsidy fertilizers improves the production quantities of farmers and hence livelihood sustainability.

On the other hand, lack of access to reliable markets and prices leads to households food insecurity and low income. A study by Lyimo-Macha *et al.* (2005) indicated that the unreliability of markets and low prices (farm gate prices) of the products were among the most common problems affecting marketing and farmer's income in relation to actual production costs. Moreover, inefficient markets and seasonal variations in market prices affect the contribution of homegarden technologies.

#### **2.4.7 Land shortage**

Land shortage is among the hindering factor in production to rural communities. Fernandes *et al.* (1984) reported that in Kilimanjaro average land size hold per household is 0.68 ha of which needs a strategic plan to improve their productivity.

#### **2.5 Measures required for Agroforestry homegardens improvement**

According to Mariro (2009) and Rugalema *et al.* (1994), there are various factors that can be used to enhance the homegardens productivity; these include adequacy of extension services, provision of knowledge skills on homegardens management, training, and provision of incentives and use of rainwater harvest.

### **2.5.1 Adequacy of extension services**

An adequate extension service is a mile stone for the homegardens improvement, as they can enhance the technology transfer to farmers effectively (URT, 1997). Mariro (2009) reported that there is a need for the government to improve the working environment of extension staff so as to encourage them; for example in service training this can enable them to go hand in hand with the changing technologies also their performance efficiency.

### **2.5.2 Knowledge provision to farmers on Agroforestry homegardens management**

Provision of knowledge to farmers can lead to production increase which would motivate them to use the technologies. Therefore, coming in line with the national goal of poverty alleviation we need a strategic plan that will enhance the production capacity by empowering farmers with knowledge provision (URT, 2005). Furthermore, Chirwa *et al.* (2006) and Nair and Kumar (2008) reported that intensive tree pruning and proper arrangement of trees lead to increased productivity from homegardens. This implies that knowledge and skills provision to farmers is a mile stone to farmers' livelihoods improvement.



## **CHAPTER THREE**

### **3.0 MATERIALS AND METHODS**

#### **3.1 Description of the Study Area**

The study was conducted in Mbeya Rural District, Tanzania. The Mbeya Rural District is located in the Southern Highlands of Tanzania and it lies between latitudes 7° and 9° South of Equator and between longitudes 33° and 35° east. The District has a total land area of 2 432 square km equivalent to 243 200 ha of which 189 818 ha is arable land ideal for agricultural production. 47 354 ha covered by forests and 6 028 ha under water bodies as well as unusable land (URT, 2010). It borders Mbarali District to the east, Rungwe and Ilege Districts to the south, Mbozi District to the west and Chunya District to the north.

##### **3.1.1 Topography and climate**

Topographically, Mbeya Rural District is characterized by highlands, mountainous peaks and lowlands of Songwe river valley. The most predominant natural vegetation includes tropical savannah and wooded grassland which lie at an altitude ranging from 2 300 to 2 800m above sea level. Average temperature ranges between 12 and 30°C annually. Average annual rainfall ranges between 650mm to 2700mm (URT, 2010).

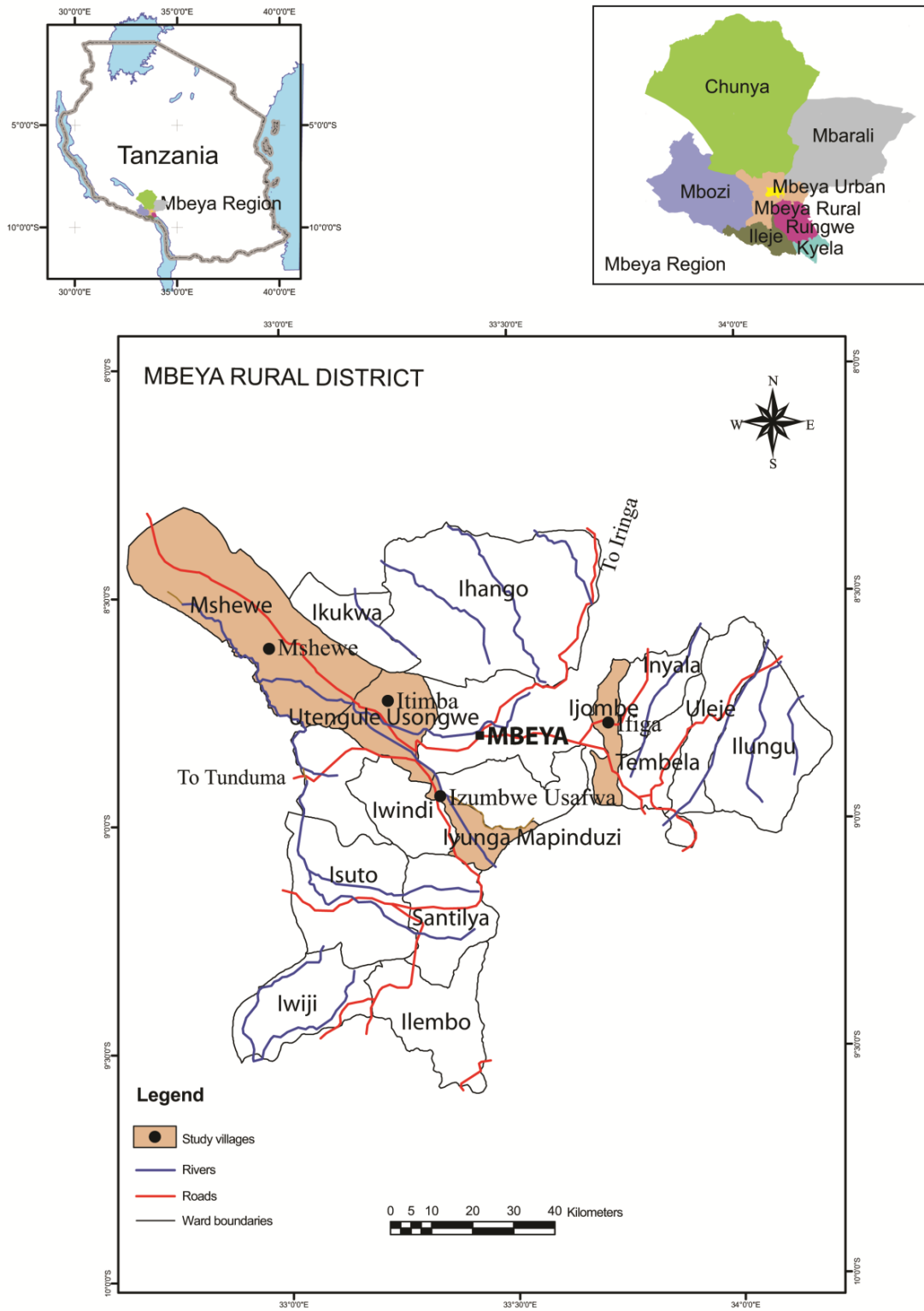


Figure 1: Map of Mbeya Rural District indicating the surveyed area

### **3.1.2 Population size and growth rate**

Mbeya rural District had a population of 254 897 people by the year 2002 after the national population and housing census conducted in August 2002 (URT, 2002). According to population projections of 2010, Mbeya Rural District is projected to have a population of 310 321 people with a population density of 127.6 people per sq. km. DED (2012).

### **3.1.3 Economic activities**

Economically, Mbeya Rural District is based on agriculture, livestock, forestry and mining as the main sources of income. More than 85% of the District gross domestic product comes from agriculture. Therefore, agriculture is the mainstay of the District economy (URT, 2010).

## **3.2 Methods**

### **3.2.1 Sampling procedures and sample size**

A simple random sampling technique was used to select wards, villages and the number of heads of households in the study area. Four wards with one village from each ward were selected and a minimum of 30 households were interviewed in each village whereby other members of households were encouraged to give support to the head in order to get more accurate data and information. This sample size was recommended by Bailey (1994) cited by Mbeyale (2009) and Akitanda (1994), who indicated that a sample of at least 30 units is sufficient irrespective of the population size. Table 1 shows distribution of population, households and sample sizes in each study village.

**Table 1: Distribution of respondents in the surveyed area**

Ward	Village	Total No. of hhs	Total sampled households
Utenguleusongwe	Itimba	350	30
Mshewe	Mshewe	533	30
Ijombe	Ifiga	294	30
Maendeleo	Izumbweusafwa	300	30
<b>Total</b>		<b>1 477</b>	<b>120</b>

### 3.2.2 Data collection techniques

Both primary and secondary data were collected. Primary data was collected through various social economic survey techniques, whereby background information on Agroforestry homegarden technologies practiced, sources and quantities of household food and income generation were identified, the contribution of Agroforestry homegardens to households food supply and income generation were obtained in the study area.

#### 3.2.2.1 Reconnaissance survey

This technique was used by the researcher to familiarize with the study area and obtain critical information from the district, ward and village officials that helped in better planning the study and scheduling the data collecting process. Also was valuable mechanism of controlling the quality of data that was collected.

### **3.2.2.2 Household data collection**

Through structured and semi structured questionnaire, socio economic data were collected. Both closed and open ended questions were employed for interviewing household heads to determine their farming practices, number of dependants, various sources and quantities of income and food supply, sources of firewood, its availability and prices, the type of integrated trees, crops, livestock products, amount of food and income obtained from Agroforestry homegarden components (amount in kilogram/ year, litres/yr, bunches/yr, pieces/ year, months of availability and its prices). Checklist of probe questions was used to obtain information from key informants including DALDO, DEO, DPLO, WEO, and VAEO. Focused group discussion was used to explore information from business working groups of farmers at village levels.

Note: The income determination in this study was based on product of farm yield estimates and its farm gate prices used at the time of selling and sources of household food security and income generation were identified basing on the homestead closeness (i.e. those products around homestead were termed as Agroforestry homegardens and outside homestead as other sources)

### **3.2.2.3 Observation method**

Direct researcher observations were made on the selected household farm fields concerning the general condition of their farming practices, identification of various Agroforestry homegarden technologies practiced in the study area, their component arrangements such as tree crop components, tree crop animal components and type of trees/shrub species used in their farms and their amount.

#### **3.2.2.4 Secondary data**

Secondary data were collected from office periodic reports and publications from local authorities, institutions, government offices, libraries (i.e.SNAL at SUA) and from websites.

#### **3.2.3 Data Analysis**

Both qualitative and quantitative data were summarized, coded and analyzed. Statistical Package for Social Sciences (SPSS version 16) was used to obtain the central tendency (means and percentages) and dispersions (frequencies and deviations) through descriptive and multiple response analysis. Analysis of Variance (ANOVA) was used to determine the significant difference between means through Costat analytical Programme. The Least Significance Difference (LSD=0.05) was used to separate the non-significant means from significant means.

Content analysis method was used to handle the qualitative data/ information from key informants and community working group business. The component of verbal discussion were analyzed in detail with the help of content analysis method in which recorded dialogue with respondents was broken down into smallest meaningful units of information and tendencies.

## CHAPTER FOUR

### 4.0 RESULTS

#### 4.1 Extent of Agroforestry Homegardens Usage in Mbeya Rural District

##### 4.1.1 Extent of Agroforestry homegardens adoption

The results on the extent of the Agroforestry homegardens adoption in Mbeya Rural District are presented in Table 2. They indicate that 99 % of the households in the District are practicing Agroforestry homegardens. The findings also indicate that the adoption is more or less evenly spread through the whole District.

**Table 2: Usage of Agroforestry homegardens in Mbeya Rural District**

Ward of the Respondents	frequency	Percent
U/usongwe	30	25
Mshewe	30	25
Ijombe	29	24
Maendeleo	30	25
<b>Total</b>	<b>119</b>	<b>99</b>

##### 4.1.2 Types of Agroforestry homegardens systems and technologies practiced in Mbeya Rural District

The results on the types of Agroforestry homegardens technologies practiced in Mbeya Rural District are presented in Table 3. Two types of Agroforestry homegarden technologies are found in the study area. These include Agroforestry homegardens consisting of trees/shrubs mixed with herbaceous/ annual crops (Agrosilvicultural

homegardens system) and the Agroforestry homegardens of tree /shrubs mixed with herbaceous crops and animals (Agrosilvopastoral homegardens system). The results indicated that 80% of the district community preferred more to use Agroforestry homegardens of Agrosilvopastoral system.

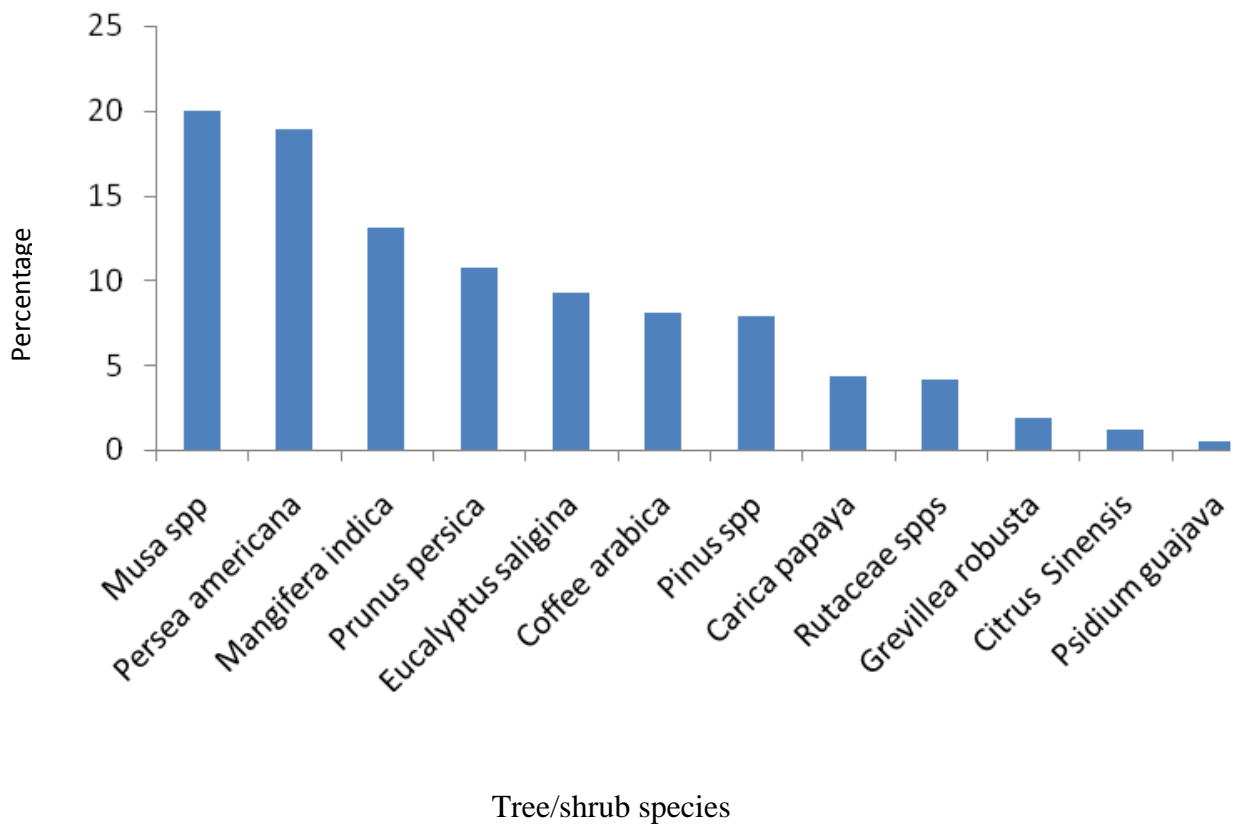
**Table 3: Types of Agroforestry homegardens technologies identified in Mbeya Rural District**

<b>S /No</b>	<b>Type</b>	<b>frequency</b>	<b>Percent</b>
1.	Agrosilvicultural homegardens	24	20
2.	Agrosilvopastoral homegardens	96	80
	<b>Total</b>	<b>120</b>	<b>100</b>

#### **4.1.3 Tree/shrub species planted in Agroforestry homegardens of Mbeya Rural District**

The results on the tree/shrub species found in the study area are presented in figure 2 with details in Appendix 2. Banana (20%), avocado (18.9%), mango (13.1%), and peach (10.7%) were the most planted species. This was probably due to their multiple functions they have as they can provide immediately fresh and nutritious fruits that sustain their households with food and income. At the same time they provide fuel wood and building materials.

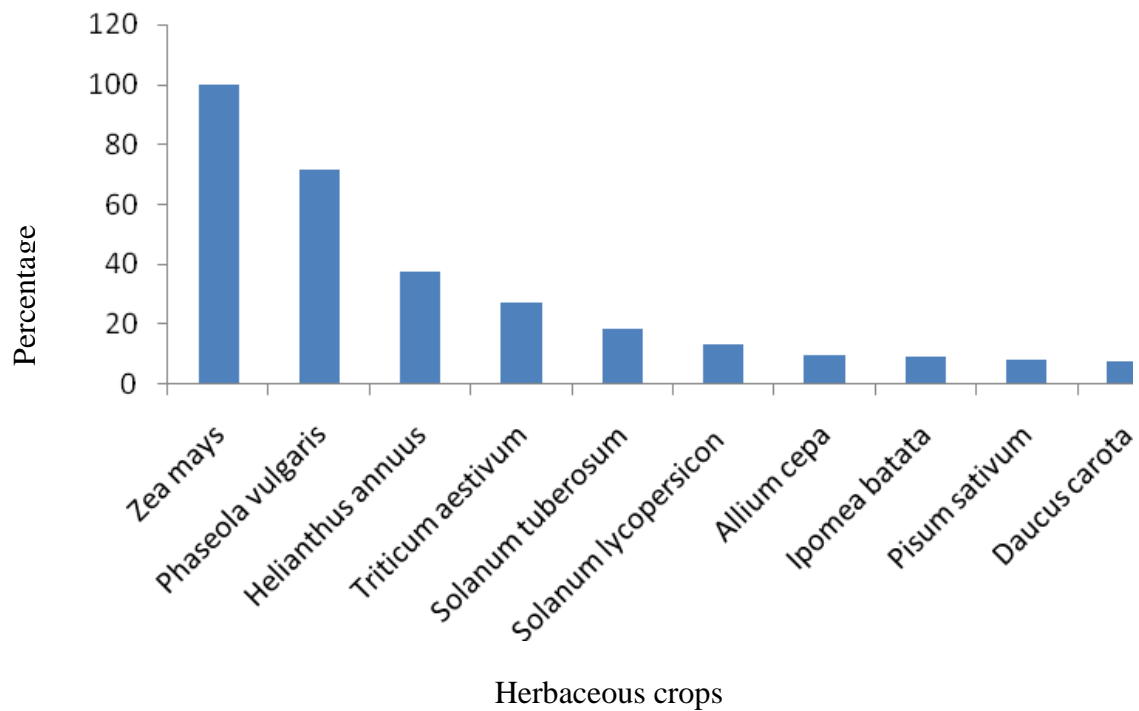




**Figure 2: Tree/shrub species of Agroforestry homegardens found in Mbeya Rural District**

#### **4.1.4 Herbaceous crops grown in Agroforestry homegardens of Mbeya Rural District ranked in terms of their importance**

Figure 3 (with their details in Appendix 3) showed the most common herbaceous crops grown in the study area. Maize (100%) and beans (71.7%) were the most grown herbaceous crops by Mbeya rural communities.



**Figure 3: Herbaceous crops grown in Mbeya Rural District ranked in terms of their importance**

#### **4.1.5: Common types of livestock found in Agroforestry homegardens in Mbeya Rural District**

The results on the common types of livestock found in Agroforestry homegardens of Mbeya rural are presented in Table 4. These were chicken, goats, cattle, pigs, sheep and other livestock (rabbits and ducks). This implied that chicken keeping was the commonest to majority of the community in the study area. Probably due to easiest method of keeping and involving low investment since they can be kept free ranging and housed inside peoples living houses.

**Table 4: Livestock component found in Mbeya Rural District**

Type of livestock	U/utengule	Mshewe	Ijombe	Maendelelo	Total	Percent
Chicken	18	17	12	21	68	41
Goat	9	6	7	14	36	21
Cattle	11	8	5	10	34	20
Pig	4	8	3	1	16	10
Sheep	4	3	2	0	9	5
<b>Total</b>	<b>49</b>	<b>43</b>	<b>29</b>	<b>47</b>	<b>168</b>	<b>100</b>

#### 4.1.6 Various Agroforestry homegardens technologies used in Mbeya Rural District

The results indicated that various Agroforestry homegardens systems consisted of various technologies that include live fences intercropping, alley farming, mixed intercropping and shelterbelt/wind break intercropping as shown in plates 1, 2, 3 and 4.

Various arrangements of Agroforestry homegardens found in the study area



**Plate 1: Live fence homegardens arrangement**



**Plate 2: Alley farming homegardens arrangement**



**Plate 3: Mixed cropping homegardens technology arrangement**





**Plate 4: Shelter belt/windbreak homegardens arrangement**

## **4.2 Various sources of Household Food Security and Income Generation in Mbeya Rural District**

### **4.2.1 Various sources identified in study area**

The results on various sources of household food security and income generation identified in Mbeya Rural District are presented in Table 5 (with details in Appendix 4). The results indicated that six sources of household food supply and income generation were identified: agriculture, Agroforestry homegardens, forestry, livestock, business and employment. Agriculture and homegardens revealed to be the major sources of household food security and income generation in Mbeya rural communities.

**Table 5: Various sources and quantities of household food security and income generation in Mbeya Rural District**

<b>Various sources</b>	<b>Frequency(count)</b>	<b>Percent (%)</b>
Agriculture	120	100
Homegardens	118	98
Forestry	55	46
Livestock	21	18
Business	18	15
Employment	5	4

#### **4.2.2 Quantities of various sources of food security and income generation in the study area**

The results on the quantities of various sources of household food security and income generation are presented in Table 6 (with details in Appendices 5 and 6 and the associated statistical data analysis in Appendix 7). On average, Agroforestry homegardens and agriculture indicated to be the main sources of household food security and income generation in Mbeya Rural District at significant level of ( $p < 0.05$ ) followed by employment and forestry. However, the results showed that their significant differences between sources were not much.

**Table 6: Average annual quantities of household food and income in Tshs between Various Sources**

<b>Sources of Food</b>	<b>Average total quantities (Tshs/ year)</b>
Homegardens	845 773a
Agriculture	675 831ab
Employment	405 000 bc
Forestry	315 582 bc
Livestock	284 667 bc
Business	182 720 c

Note: Values in the same column with the same following letter do not differ significantly (p<0.05)

### **4.3 The Contribution of Various Sources and Quantities of Household Food Security and Income Generation in Mbeya Rural District**

#### **4.3.1 The contribution of various sources and quantities to household food security in Mbeya Rural District**

The results on contribution of various sources of household food security and income generation in Mbeya Rural District are presented in Table 7 (with a detailed data and associated statistical analysis in Appendices 8 and 9 respectively). Generally, Mbeya rural communities depend on various sources with agriculture being the highly significant (p<0.05). Agroforestry homegardens come as the second most important contributors to the district household food security. This implied that agriculture and Agroforestry homegardens are the main occupation to the majority of Mbeya rural communities.

**Table 7: Contribution of various sources of household food security among community in Mbeya Rural District (Tshs/year)**

<b>Sources</b>	<b>Average food supply (Tshs/year)</b>	<b>Percent</b>
1.Agriculture	246 017 a	47
2.Homegardens	89 679 b	17
3.Employment	55 000 bc	10
4.Forestry	50 722 bc	10
5.Livestock	44 077 c	8
6.Business	41 250 c	8

Note: Values in the same column with the same following letter do not differ significantly (p<0.05) LSD 0.05= 39 312.94

#### **4.3.2 Contribution of various sources and quantities to household income generation**

The results on contribution of various sources to household income generation are presented in Table 8 (with the detailed data and associated statistical analysis in Appendices 10 and 11). On average, Agroforestry homegardens and agriculture indicated high proportions on contribution to household income generation among Mbeya rural communities followed by business. This was probably implied that most of the Mbeya rural communities depend relatively on various sources for their livelihoods.



**Table 8 Contribution of various sources to household income generation in Mbeya Rural District**

<b>Sources</b>	<b>Average Income supply ( Tshs/year)</b>	<b>Percent</b>
Homegardens	536 415 a	25
Agriculture	425 284 ab	20
Business	405 000 ab	18
Forestry	314 058 ab	15
Livestock	284 667 ab	13
Employment	182 720 c	9

Note: Values in the same column that are followed by the same letter do not differ significantly ( $p < 0.05$ ), LSD 0.05 = 67 323

#### **4.3.3 Reasons for household food shortages in Mbeya rural communities**

Results on household food shortage among Mbeya rural communities are presented in Table 9 (with details in Appendices 12 to 16). The results indicated that low capital, high input prices and unreliable rainfall caused the community to face food shortages. Majority of the interviewed households faced food shortage during rainy season mostly between December and March. Buying food from market and doing casual laborers were the coping strategies that the community adopted timely with during food shortage.

**Table 9: Reasons for household food shortages in Mbeya Rural District**

<b>Reasons for yield decrease</b>	<b>Percent</b>
Low capital	47
High inputs prices	30
Unreliable rainfall	19
Subsidy fertilizer delay	14
Sickness	7
Pest and d'ses infestation	6
Poor crop rotation	6
Land degradation	6
Too much rainfall	1
Poor technologies	1

#### **4.4 Factors affecting Agroforestry homegardens contribution to household food supply and income generation in Mbeya Rural District.**

##### **4.4.1 Factors that motivated people to use Agroforestry homegardens to household food and income generation**

The results on the factors that motivated to use Agroforestry homegardens technologies in household food security and income generation are presented in Table 10 (with their detailed data in appendix 17). Having sufficient food throughout the year, getting income and diverse products to their families were the most influencing factors for the Mbeya rural communities to adopt Agroforestry homegardens technologies.

**Table 10: Factors that motivated people to use Agroforestry homegardens technologies to household food security and income generation in Mbeya Rural District**

<b>Factors Motivated</b>	<b>Frequency</b>	<b>Percent</b>
Having sufficient food throughout the year	71	42
Getting income	61	36
Having diverse products	28	16
Helps in life risks reduction	7	4
Help in shade provision	3	2
<b>Total</b>	<b>171</b>	<b>100</b>

#### **4.4.2 Factors that limit the contribution of Agroforestry homegardens to household food security and income generation in Mbeya Rural District**

The results on factors limiting the contribution of Agroforestry homegardens in household food security and income generation in the study area are presented in Table 11 (with the detailed data in Appendices 18 to 21). Crop competition, low capital, unreliable markets and low prices of crops led to majority of the Mbeya rural communities to become disappointed to adopt the Agroforestry homegardens technologies.

**Table 11: Factors limiting the contribution of Agroforestry homegardens in household food security and Income generation in the study area**

<b>Factors limiting</b>	<b>Frequency</b>	<b>Percent</b>
Crop competition	49	32
Low capital	43	28
Unreliable market of products	28	18
Low crop prices	12	8
Land shortage	11	7
Shortage of irrigation water	8	5
Conflict to neighbors	5	2
<b>Total</b>	<b>155</b>	<b>100</b>

#### **4.4.3 Measures required in improving the contribution of Agroforestry homegarden technologies to household food security and income generation**

The results on the measures to be taken in improving the contribution of Agroforestry homegarden technologies to household food security and income generation in Mbeya Rural District are presented in table 12 (with details in Appendix 22). Credit facilities provision was the most significant measure to improve the performance of homegardens technologies in the district.

**Table 12: Measures required in improving the contribution of homegardens to household food security and income generation**

<b>Type of measure</b>	<b>Frequency</b>	<b>Percent</b>
Credit facilities provision	34	25
Knowledge provision	31	23
Earlier subsidy fertilizer provision	24	18
Reduction of fertilizers price	15	11
Provide fertilizer subsidies to all sellers	14	11
Market availability	8	6
Agricultural extension officers to have demonstration plots	3	2
Type of tree selected	3	2
Land separation to each crop	1	2
<b>Total</b>	<b>133</b>	<b>100</b>

## CHAPTER FIVE

### 5.0 DISCUSSION

#### 5.1 Extent of Agroforestry homegardens usage in Mbeya Rural District

Tables 2 to 4 (with their details in Appendices 2 and 3) and plates 1 to 4 show the extent and the identified homegardens in Mbeya Rural District. The results show that majority of the Mbeya rural communities practice homegardens technologies by 99%, implying that majority are aware of the technologies as discussed by Kitalyi *et al.* (2006), although their existence have not yet recognized nor documented. The results also indicate that adoption of the Agroforestry homegardens is more or less evenly spread throughout the district. This could possibly be due to the fact that Mbeya Rural District is among the most endowed districts with high rainfall and different climatic regimes ranging from tropical to temperate climates as reported by DED (2012). Also the study area shows to have various economic opportunities that influence people to migrate from different areas to come and invest. Furthermore, the report showed that Mbeya Rural District is among the densely populated area whereby land fragmentation was obvious. This has resulted into land scarcity as discussed by Rugalema *et al.* (1992; 1994). Musotsi *et al.* (2008) in Northern Kenya reported that land fragmentation leads to negative food production and hence food insecurity. Land use practices thus have to be intensified to maximize food production on a small land available.

Agroforestry homegardens can make a significant contribution in meeting the daily households' needs. These results agree with findings by Fernandes *et al.* (1986) who reported that homegardens are the best solution to all areas with high population density.

Abebe (2005) also reported that Chagga homegardens cited as model example of land use management to abate environmental deterioration as well as biodiversity conservation.

Two types of Agroforestry homegarden technologies were found in the study area with various structural arrangements. These were Agroforestry homegardens of trees mixed with herbaceous crops (Agrosilvicultural homegardens) and the Agroforestry homegardens of tree /shrubs mixed with herbaceous crops and animals (Agrosilvopastoral homegardens). The results show that 80% of the District communities preferred Agroforestry homegardens of Agrosilvopastoral system. The multiple production function from these technologies assured them access to food and income throughout the year. Also the biophysical advantages offered by these multi-species composition (efficient cycling nutrients) and conservation of bio-cultural diversity. This results are in line with report given by Nair (1986); Nair and Kumar (2004);Tolunay (2008);Bassullu and Tolunay (2010) that traditional Agroforestry homegardens involving animal component with growing various trees, small trees, shrubs and similar wood-like species and agricultural products have high output compared to those without it if are well managed. Also FAO (1996); Tewari (1994); Makino (2003); Hassanuzzaman (2008), reported that diverse production from various components (tree/shrub/annual crops/animals) provided food security to a large low-income population particularly during periods of drought and works as an insurance against famine and crop failure.

The results also indicate that various homegardens technologies were arranged as live fences mixed cropping arrangement and alley farming arrangements for land use

effectiveness. The results are similar to those reported by Nair (1993) as discussed in the literature review.

Banana, avocado, mango and peach were the most common tree/shrub species found in the homegardens of Mbeya Rural District. The results agreed with those reported by Kebebew *et al.* (2011); Maroyi, (2009) in Ethiopia and Zimbabwe.

The occurrence of tree/shrub species in the study area differ between wards depending to ecological distribution. Through observation technique, the study showed that tree/shrub species like banana, avocado and Eucalyptus were found in all ecological zones (i.e from low altitudes of Mshewe and Usongwe with altitudes of 700-1500 m a.s.l) to high altitudes of Ijombe and Maendeleo with an altitudes above 1900m a,s.l). Pawpaw, orange, mango, grevillia and citrus tree/shrub species suited only in low altitudes. Peach and pine tree species suited only in high altitudes. Ijombe and Maendeleo wards are within the Uporoto mountains continuation, which cannot support well some of the annual crops like maize and beans , therefore majority of the communities planted tree species (Pines and Eucalyptus) for income generation and land conservation. Due to this fact, is the main source of income generation in Ijombe and Maendeleo wards as reported by URT (2012).

On the other hand maize and beans are the most herbaceous crops grown by Mbeya rural communities; as these are the major food crops in the study area. The results are similar with the results of URT (2012) and Bisanda *et al.* (1998). Coffee and pyrethrum are the main cash crops in the study area whereby pyrethrum is grown in Ijombe and Maendeleo wards while coffee is grown in Utengule usongwe and Mshewe wards.



Livestock keeping is another homegardens component in the study area. Different households keep different species of livestock. In the highlands of Ijombe and Maendeleo wards, majority of livestock are kept under stall-feeding. While in the lowland areas of Mshewe and U/utengule, free-range livestock keeping is practiced. Most of the Mbeya rural communities in the study area keep local and cross breed types of livestock and only few of the households keep exotic breeds of cattle, goat and pigs. The types of livestock kept are chicken, goat, cattle, pigs, sheep and other livestock (rabbits and ducks). This means that chicken keeping is the commonest to the majority of the communities in the study area. This implies that chicken keeping is the simplest investment as reported by URT (2010).

The study also shows that majority of the rural households keep more than one type of animals as a strategy to maximize profit as well as risk reduction in food supply and sufficient income to the family. Jensen (1993a, b) and Wilson (1995) reported that diverse livestock keeping contributed significantly to the household income of small-scale homegardens in many developing countries to fulfill many social and cultural needs. Also due to limited land size owned by the majority of the community as shown in appendix 14 make households to diversify their production. This justifies adoption of Agroforestry homegardens technologies in the study area. Devendra and Thomas (2002) indicated that in some of the very small gardens, where land was a constraint to production, livestock were sometimes the main income generators, serving as cash buffers and capital reserves. Apart from income generators, livestock also contributed to the nutrient cycling in the system (Jensen, 1993b; Thorne and Tanner, 2002; Hailu, 2008). On the other hand, the study shows that all households with animal component benefited from animal products

like milk, meat and animal manure by adding their nutritional status to their families as well as increasing their farm crop yields by improving soil fertility of their farms using animal dung.

## **5.2 Various Sources and Quantities of Household Food Security and Income Generation in Mbeya Rural District**

The results on the various sources and quantities of household food security and income generation in Mbeya Rural District are presented in Tables 5 and 6 (with their details in Appendices 4 to 11). Six sources of household food security and income generation were identified in the study area; these are Homegardens; agriculture, forestry, livestock, business and employment. Generally Mbeya rural communities seem to depend on various sources of household food security and income generation with Agroforestry homegardens being the main sources of relatively livelihoods dependence at level of ( $p < 0.05$ ). The results agree with the study done by Trinh *et al.* (2003); Gautam *et al.* (2004); Bonifasi (2004) and Das and Das (2005) that Agroforestry homegardens are the important sources of household food and income in the world.

On the other hand, agriculture has the highest contribution to food supply and the second to income generation in the study area. These results are in line with a report by URT (2010) that about 85% of the District population depends on agriculture as their main food supply source. The importance of agriculture has also been explained at national level whereby the dependence of Tanzanians on agriculture sector as a source of livelihood was about 80% (URT, 1997; (Myaka *et al.*, 2003).

Also agriculture is the backbone of the Tanzanian economy in terms of production, employment, income and foreign exchange generation (Nyoni, 2007). However, contribution of agriculture to household food supply and income generation in terms of quantity was low compared to homegardens. This is because that majority of the interviewed households complained to have low capital to invest in agriculture as a single cropping system (monoculture), since it required high capital compared to homegardens.

High prices in agricultural inputs led majority of the communities to end up with low yields due to low purchasing power. As result they only applied topdressing fertilizers rather than using both basal and topdressing fertilizers. This result is contrary to that of a study done by Dorward *et al.* (2008) in Malawi where they tried to improve the smallholder maize production by subsidizing the agricultural inputs timely through agricultural Input Subsidy Programme (AISP). The results showed that in two years' time their production trends increased.

Unreliable distribution of rainfall on the other hand, affected contribution of food supply from agriculture. Majority of the households interviewed in the study area depended on rain fed agriculture which leads to frequent crop failures, resulting to low contribution of household food supply, hence household food insecurity as reported by FAO (1996); Nyange (2000); DAPD (2006/2007); Shilabu (2008). Also pests and diseases, inadequate input use, poor use of farm tools and poor husbandry could be other factors affecting agriculture sector hence lowering contribution to household food and income supply. This result is in line with a study done by Makundi (1996); SUA (2006) that the fore mentioned reasons led majority of the household to food insecurity.

However, there are coping strategies that the Mbeya rural communities used to overcome the household food shortages. These included buying food from market and doing casual labour. The results are contrary to Macandog *et al.* (2003) of Northern Philippines who reported that enhancement of homegardens establishment; improved livestock production; integration of tree species provided biophysical benefits. Not only had that but also increased the soil fertility through fallow system. This therefore, shows that Agroforestry homegardens technologies are the best options in community livelihoods sustenance

### **5.3 Contribution of Agroforestry Homegardens to Household Food Security and Income Generation to Livelihoods of Mbeya Rural Communities**

Tables 7 and 8 (with details in Appendices 8 to 11) presented the results on the contribution of various sources of household food security and income generation in Mbeya Rural District. The results indicate that Agroforestry homegardens ranked highest proportion in contributing to household income generation per year compared to other sources, and second to agriculture on household food supply. As Agroforestry homegardens consisted more than one components (tree/shrubs/ annual crops; tree/shrubs/annual crop/livestock components) which favoured the community's access to food and income throughout the year as reported by FAO (2004). Ndaeyo (2007) reported that food security was of paramount importance to communities' livelihoods as it was the central well-being of any creature. Therefore, Agroforestry homegardens significantly improved the household financial and food statuses of the communities as discussed by Fernandes *et al.* (1984); Bishaw and Abelkadir, (2003).

Furthermore, Lulandala (2011) and Krishnal (2012) reported that Agroforestry homegardens reduced the cost of labour as most of activities in homegardens operated by family labour. Twenty five (25%) and seventeen percent (17%) of Mbeya rural community's income and food requirement per year contributed by homegardens respectively. However, the Agroforestry homegardens products sold varied highly from one household to another. These results were similar to Marsh, (1998); Trinh *et al.* (2003); Tynsong and Tiwari, (2010) that Agroforestry homegardens contributed much to the community's livelihoods. Motiur *et al.* (2005) reported that an average of 15.9% and 11.8% of the South-West and North-Eastern Bangladesh households' income derived from homegardens respectively. Therefore, Agroforestry homegardens remain the main occupation for income generation and food supply to rural communities as reported by Fernandes *et al.* (1986); Mendez *et al.* (2001); Maroyi *et al.* (2009); Guuroh *et al.* (2011).

Agroforestry homegardens also can be described as an important social and economic unit of rural households, from which a diverse and stable supply of economic products and benefits are derived. The results from respondents' point of view indicate that combination of herbaceous crops with different production cycles and rhythms resulted into an uninterrupted supply of food products as discussed by Maroyi (2009). This assures Mbeya rural communities to be food and income secured as reported by Fernandes and Nair (1989); Kajembe *et al.* (2000); Beckford *et al.* (2011); Nair (2012). In line with this significance of homegardens, there are various factors that can either influence or limit the community's adoption of the Agroforestry homegardens technologies. However, in Mbeya Rural District the results showed that majority of the communities adopted the technologies.

## **5.4 Factors Affecting Contribution of Agroforestry Homegardens to Household Food Security and Income Generation in Mbeya Rural District**

### **5.4.1 Factors influencing contribution of Agroforestry homegardens to household food and security and income generation**

The results on the factors influencing contribution of Agroforestry homegardens to household food security and income generation are presented in Tables 11 and 12 (with their detailed data in Appendices 17 to 21). The contribution of homegardens to household food security and income generation in Mbeya Rural District was influenced by both positive and negative factors.

On average, majority of the interviewed households are positively motivated to use the Agroforestry homegardens technologies because of sufficient food and income obtained throughout the year and by having diverse products. The results of this study are similar to Guuroh *et al.* (2011) that homegardens played a vital role in supporting households in many diverse ways, including the provision of food, fuel wood, building materials, and fodder for livestock, and income. They are regarded as a source of income diversification and also play a crucial cultural and social role in rural communities. Moreover, Tynsong and Tiwari (2010) reported that in times of food scarcity, homegardens with their diverse products available year round, contributed towards food security.

On the other hand, crop competitions the main significant factor affecting the rural households to use the Agroforestry homegarden technologies. This is because majority of the communities lack skills on the tree management and arrangement, due to insufficient farmer training. Competition for shade, light, soil moisture and nutrients between

components increased disappointment to farmers. Trees as the main component in the technologies may outcompete arable crops for nutrients, growing space, and light and soil moisture and may reduce the yields of the associated crops as discussed by Kumar and Nair (2004). Therefore, this effect caused negative perception to farmers on the use of technologies. Njuki (2001) reported that crop competition was the major constraint to the integration of trees into farming technologies as majority of the communities have not known the right tree species that can be used to integrate properly in their fields.

Moreover, low capital and inaccessibility to credit facilities hindered the adoption of the Agroforestry homegardens in the study area. Though there was ward bank (SACCOS) in the study area, still the registration regulations were too stringent and fees were too high that lead to many of the communities not to afford joining. Some of the communities were not aware of the existence of the ward bank institution. Credit facilities have helped many people to come out of poverty. The facilities lead them to increase their production by accessing the required inputs and improve the contribution of the Agroforestry homegarden technologies and hence improve their household food security and income generation. The results from this study, however, are contrary to that of Smale *et al.* (2009) that credit facilities are the corner stone's for the rural farmers' development.

Apart from this, through focused group discussion, the business group dealing with production and processing of various products from fruits to add value argued that lack of capital hindered them from reaching their goals of production.

Furthermore, unreliable markets in the study area were another factor that caused the communities to be disappointed to adopt Agroforestry homegardens technologies. As they sold their products under farm gate markets (85.8%) with a very low prices resulting into low earnings hence low contribution of the homegardens and household food insecurity. Baiphethi and Jacobs (2009) reported that reliable markets to rural farmers may improve their livelihoods.

Land shortage on the other hand constrained the communities to use homegardens technologies in the study area as discussed by Musotsi *et al.* (2008). The results indicated that there was land shortage in the District and the farmland was highly fragmented with land holdings ranging from 0.25 – 12 acres with an average acreage of 2.6 acres per household. In general 75% of the selected households were under class having land size between 0.25 and 3.0 acres with Ijombe being the most leading ward by 96.7%. These results were contrary to that of Fernandes *et al.* (1984) who reported that the average land size owned per household in Kilimanjaro was 0.68ha greater than that owned by Mbeya rural communities. The results show that all available land is intensively cultivated and hampered the efforts to increase production and demand of food by Agroforestry homegardens. However, renting and purchasing land occur in areas which seemed to have enough land as an opportunity of which favors few rich farmers.



#### **5.4.2 Measures required in improving the contribution of homegardens technologies to household food security and income generation in the study area**

The results on the measures to be taken in improving the contribution of homegarden technologies of household food security and income generation in Mbeya Rural District are presented in Table 13 (with details in appendix 22). Credit provision is the most significant factor to improve the performance of homegarden technologies in the district. It was found that majority of the interviewed respondents faced difficulties in accessing credits from the financial institutions (Ward SACCOS) though access to financial services is crucial to economic growth and poverty reduction in the society URT (2005). This was probably because of poor knowledge on banking operations leading to majority of the rural dwellers to remain poor. However, even where people understand the banking operations, the requirement for collateral (guarantees) by most financial institutions impedes provision of credits. A high entrance fee rate to financial services (Ward SACCOS) is the stumbling block to access loans by respondents. As reported in the Daily Newspapers 28<sup>th</sup> February by Mrindoko (2012) that in Tanzania ignorance on banking operations impedes access to credit facilities. IFAD (2012) reported that lack of rural credit facilities led to low crop production resulting into low yields and hence food and income insecurity.

Lack of knowledge on how to access and use credits resulted into poor homegardens operation leading to low yields. Therefore knowledge provision to all homegardens owners is of importance to overcome food shortages to the households. Also there should be open and easy access to credit facilities and entrance to all people so as to improve their

homegardens production. Agroforestry homegarden technologies are among the best ways in areas with high population like Mbeya Rural District to sustain the communities' livelihoods. For example in Bangladesh, a most densely populated country in the world (with 129 million people), over 76% of the population live in rural areas and they are heavily dependent on homegardens for their livelihood and serve as safety net during the time of hardship and natural disasters (Motiur *et al.*, 2006).

Knowledge through training provision to farmers on the other hand can contribute in improvement of homegardens production. Majority of the respondents lacked knowledge on component arrangement and management which lead to low yields. Therefore provision of training to farmers will enhance homegardens production resulting into food security and income sustainability. Chirwa *et al.* (2006) and Nair and Kumar (2008) revealed that intensive tree pruning and planting of trees on proper arrangements led to increased productivity of the Agroforestry homegardens.

## CHAPTER SIX

### 6.0 CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 Conclusions

From the foregoing discussions, the following conclusions are drawn from this study:

- i. The findings show that Mbeya Rural District has been practicing the Agroforestry homegarden technologies by 99% though has not yet been recognized and documented. Two types of Agroforestry homegardens technologies are found in the study area. These are Agrosilvicultural and Agrosilvopastoral homegarden technologies. Eighty percent (80%) of the Mbeya rural communities preferred to use the Agrosilvopastoral homegardens technologies for production diversification and profit maximization.
  
- ii. Six sources of household food security and income generation were identified and indicated that Agroforestry homegardens and agriculture were the main sources of sustenance both for food and income in the study area. Agroforestry homegardens ranked the highest contributing source to the livelihoods of Mbeya rural communities. Furthermore, Agroforestry homegardens also show the highest proportions in contributing to household income generation and ranked second to agriculture in household food security contributors. Therefore, Agroforestry homegardens technologies showed to be the best options to sustain the households of the Mbeya Rural District.

- iii. Access to sufficient food and income throughout the year with diverse products in their households are the main factors that motivate the Mbeya rural communities to use Agroforestry homegarden technologies. However, crop competition, and inadequate knowledge/skills on tree management and arrangements with right tree species to integrate with their herbaceous crops are the major limiting factors to use Agroforestry homegardens technologies. Apart from this, low capital and unreliable markets were other limiting factors to adopt the Agroforestry homegardens in the area. All of these are due to inaccessibility to credit facilities, tough entrance regulations in the credit institutions and high entrance fee rates which hinder majority of the communities to access credits.
- iv. Therefore, credit and knowledge provision to all homegardens users, structural arrangements, type of tree species to integrate and its management could be the most significant factors in improving adoption of the Agroforestry homegardens technologies in Mbeya Rural District.

## **6.2 Recommendations**

Based on the results from this study, the following recommendations are put forward:

- i. Due to high rate of Agroforestry homegardens usage in the study area and its contribution, therefore this study, recommends that District policy makers and other stakeholders have to enhance and establish the existing homegardens so as to improve communities' livelihoods by increasing their production.

- ii. Inadequate knowledge on Agroforestry homegardens management, arrangement and right type of tree species for integration in the farmers' fields, resulted into low yields and hence food shortages due to crop competition. Therefore, there is a need of incorporation of these techniques and management skills into the extension activities of the relevant organizations. This will enhance full exploitation of the potentials of Agroforestry homegardens.
  
- iii Moreover, Credit facilities should be established with affordable institutional regulations for community empowerment, easy and timely access to their required Agroforestry homegardens inputs, hence high production and better living standards of the communities.
  
- iv Also well-developed homegardens policies with different perennial, annuals, and or animals should be advocated. This can play a crucial role in providing high-nutrient food, low input cost, income from product sales and food security through its production diversity.

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## APPENDICES

### Appendix 1: Questionnaire for head of households

Date of interview.....

Village.....

Ward.....

Division.....

#### A: Background Information

1. Respondent's Name.....

2. Gender: (1) male..... (2) Female.....

b) Status: (1) head of the household; (2) not head of the household

3. Respondent's Age (Years).....

4. Marital status:

(1) Single [ ] (2) Married [ ] (3) Divorced [ ] (4) widowed

5. Highest Educational level of the respondents

(a) Informal education [ ] (b) Adult education [ ] (c) Primary education [ ]

(d) Secondary education [ ] (e) Diploma colleges [ ] (f) University level [ ]

6. Respondent's main Occupation

(a) Smallholder scale farmer [ ]

(b) An employee [ ]

(c) Petty business [ ]

(e) Others (specify)

7. What is total number of your family members?

7.1 Children's below (18 years) [ ]

7.2 Adults 30-60years [ ]

7.3 Adults above 60 years [ ]

7.4 How many Labour force do you have .....

**B: Homegardens Technologies Practices**

1. Do you know about the homegardens practices? YES/ NO

2. Do you practice homegardens technologies in your area? YES/ NO

3. If no why?

.....  
.....

4. Which among the following homegardens practices do you use in your area?

- (i) Trees/shrubs/ perennial crops and Annual crops
- (ii) Trees/shrubs/annual crops /Animals
- (iii) Trees/shrubs/annual crops
- (iv) Trees/Annual crops /Animals/bees
- (v) Mixed cropping
- (vi) Trees/shrubs/annual crops /Animals/fish

5. What influenced you to use this technology?

6. What benefits do you get from using homegardens practices?

.....

7. Which type of trees species is of your preference .....

8. Why do you prefer this type of tree species?.....

9. Is there anyone who does not practice the homegardens technologies in your area?

YES/ NO

What is the reason for not using the technology?.....  
.....

10. What type of energy sources do you use.....

11.(a) Is it easy to access that firewood in your area YES/NO

( b)If no how do you access firewood for your daily use?.....

**C: Sources of Food Security**

1. What are the main sources of food to your family?

- (i) Own production
- (ii) Purchased from the market
- (iii) Aids from the government
- (iv) Remittances
- ( v) Others specify.....

2. Do you own land? YES/No

What size of your area? \

3. If no how do you access land for agriculture?

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

4. Which crops do you grow and its amount in kg /ha per year

Type of crop	Total production (bags, tin)	Amount sold in Unit (Bags, tin)and price/unit	Amount consumed kg/year	Amount stored for future use in kg/bag
Maize				
Sorghum				
Cassava				
Sunflower				
Sweet potatoes				
Beans				
Banana				
Tomato				
Wheat				
Millet				
Avocado				
Round potatoes				
Trees(timber)				
Trees(firewood)				
Others (Specify)				

5. How much of each of the sources contribute to household food security since 2009-2011?

6. (a) Do you use fertilizers YES/NO

(b) Which type of fertilizers you use.....

(c) At what amount (in Kgs/Bags) .....

7. How do you access those fertilizers .....

(a) Through subsidies

(b) Through Agricultural service shops

(c)Others specify.....

Source of food and their contribution to household food security since year 2007-2011

Sources of food security	2006/07	2007/08	2008/09	2009/10	2010/2011
Agriculture					
Forestry					
Livestock					
Employment					
Business(off-farms)					
Homegardens					
Others (specify)					

NB: Have you experienced any crop yield decrease YES/NO

If yes why .....

6. Do you keep livestock? YES/NO ..... If yes which types

(i) Cattle.....no.....

(ii) Goat.....No....

(iii) Sheep.....No.....

(iv) Chicken.....No.....

(v) Pigs.....No.....

(iv) Rates.....no ...

(v) Others specify.....



	2006/07	2007/08	2007/08	2008/09	2009/10	2010/ 2	2010/201 1
Cattle							
Goat							
Sheep							
Chickens							
Pigs							
Rates							
Others							
Total							

7. Where do you sell your (a) Agricultural products.....

(b) Livestock products.....

8. What problems do you face with agricultural Production.....

9What problems do you face with livestock

Production.....

10 How do you overcome those problems?

(i).....

(ii).....

(iii).....

(iv).....

11. What type of labour do you use in (a) agricultural activities.....

(b) Livestock activities.....

12. Which pests and diseases affect crops most in your area?

.....

13. What control measures do you use: for

Pests.....

For diseases.....

How you used your agricultural products? (i).....

(ii).....(iii).....(iv).....(v).....

**D: Food security indicators**

1. Did you experience food shortage in your household at least for two years consecutively?

Yes/No

2. For how many months in a year?.....

3. In which seasons did you experience food shortage?

4. What do you think are the reasons?

- a) Low production from homegardens
- b) Lack of enough land for cultivation of food crops
- c) Large number of dependants
- d) Low income and purchasing power
- e) Overselling of food crops
- f) Household gender division
- (g) Cultural rituals and taboos

3. What proportion the total land area is cultivated every season?

.....

4. What coping strategies do you use to overcome this food insecurity problem?

(a) Buying food (b) gifts from people (c) Remittances (d) Aids from village

Government (e) Others specify.....

**E: Factors that influence sustainability of the contribution of Agroforestry homegardens to household food security and income generation**

1. Is the land owned enough for your needs? YES/NO

2. Are there any village legislation/bylaws to supplement you with a new land area?

3. What are the laws/legislations/bylaws that govern the use of land in the village

4. (a) Are you accessible to extension services? YES/NO

(b)If NO, why? .....

(c) If YES which extension services are you accessible

with?.....

(c) Have you ever attended any training course on Agricultural education?

YES/NO

a) Are there any Agricultural extension officers in your area? YES/NO

5. Have you any knowledge acquired on the importance of homegardens? YES/NO

6. Do you think homegardens have a role in household food security? YES/NO

Mention

7. What are the main problems facing the sustainability of homegardens practices

in your area?

.....

*Thank you for your cooperation*

**Appendix 2: Checklist for Key informants: District Leaders/ward leaders/extension agents**

**/NGOs and Interested groups.**

**A. General Information**

**Number of Divisions.....Wards.....Villages.....Households.....**

1. What is the total of population of your District?
2. What is the total number of households with home gardens in Mbeya Rural District?
3. What is the main source of food in Mbeya Rural District and its status from 2005-2010?
4. What type of trees, crops and animals that are managed in homegardens and their purpose?
5. What type and quantity of food crops are produced in this ward
6. What is the total number of livestock in this ward
7. Are there any
8. Are there any Laws/legislations that govern the use of land in the village/ward/division/District?
9. Do you think homegardens have a role in household food security?
10. What are the main problems facing the sustainability of homegardens?
11. What do you think should be done to improve homegardens for food security

**Thank you very much for your good cooperation**

**Appendix 3: Types of tree/shrub species found in the study area by their respondents' frequency distribution and its uses**

S/N	Common name	Botanical name	frequency	Percentage (%)	Its uses
1.	Banana	<i>Musa</i> spp	84	20.0	Fruit, income
2.	Avocado	<i>Persea americana</i>	79	18.9	Fruit, income, fuelwood
3.	Mango	<i>Mangifera indica</i>	55	13.1	Fruit, income, fuelwood
4.	Peach	<i>Prunus persica</i>	45	10.7	Fruit, income, fuelwood
5.	Eucalyptus	<i>Eucalyptus saligina</i>	39	9.3	Poles, fuelwood, timber
6.	Coffee	( <i>Coffee arabica</i> )	34	8.1	Income, fuelwood
7.	Pines	<i>Pinus</i> spp	33	7.9	Timber, fuelwood, income
8.	Pawpaw	<i>Carica papaya</i>	18	4.3	Fruit, income
9.	Citrus/lemon	<i>Rutaceae</i> spp	17	4.1	Fruit, income, fuelwood
10.	Grevellia	<i>Grevillea robusta</i>	8	1.9	Coffeeshade, timber, fuelwood
11.	Orange	<i>Citrus Sinensis</i>	5	1.2	Fruit, income, fuelwood
12.	Guava	<i>Psidium guajava</i>	2	0.5	Fruit, income, fuelwood
<b>Total</b>			<b>419</b>	<b>100</b>	

**Appendix 4: Common annual crops found in study area ranked into their importance**

<b>S/N</b>	<b>Common name</b>	<b>Scientific name</b>	<b>Frequency</b>	<b>Percent</b>
1	Maize	<i>Zea mays</i>	120	100
2	Beans	<i>Phaseola vulgaris</i>	86	71.7
3	Sunflower	<i>Helianthus annuus</i>	45	37.5
4	Wheat	<i>Triticum aestivum</i>	33	27.5
5	R/potatoes	<i>Solanum tuberosum</i>	22	18.3
6	Tomato	<i>Solanum lycopersicon</i>	16	13.3
7	Onions	<i>Allium cepa</i>	12	10.0
8	S/potatoes	<i>Ipomea batata</i>	11	9.2
9	Gardenpeas	<i>Pisum sativum</i>	10	8.3
10	Carrots	<i>Daucus carota</i>	9	7.5
11	Millet	<i>Eleusine coracana</i>	3	2.5
12	Rice	<i>Oryza sativa</i>	2	1.7
13	Hotpepper	<i>Capsicum frutescens</i>	2	1.7
14	Cabbage	<i>Brasica oleraceae</i>	1	0.8
15	Cassava	<i>Manihot esculata</i>	1	0.8
16	S/pepper	<i>Capsicum annum</i>	1	0.8
17	Cucumber	<i>Cucumis spp</i>	1	0.8
18				

**Appendix 5: Various sources and its distribution across wards in Mbeya Rural District**

<b>Sources</b>	<b>U/usongwe</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Average Percent</b>
Agriculture	(30) 25.0	(30) 25.0	(30) 25.0	(30) 25.0	(120) 100.0
Homegardens	(30) 25.0	(29) 24.0	(30) 25.0	(30) 25.0	(118) 99.0
Forestry	(5) 4.2	(6) 5.0	(18) 15.0	(27) 22.5	(56) 46.7
Livestock	(16) 13.3	(20) 11.67	(9) 7.5	(11) 9.17	(50) 41.2
Business	(3) 2.5	(9) 7.5	(5) 4.2	(1) 0.8	(18) 4.2
Employment					

Note: Numbers in brackets are the frequency of each ward

**Appendix 6: Various sources with its detailed units contributed to household food security and income generation**

<b>Information Item</b>	<b>Total Prdn/unit</b>	<b>Food/unit</b>	<b>Income/unit</b>
<b>AGRICULTURE</b>			
Maize (Tins)	9 472.8	5 368.8	4 104.0
Beans (Tins)	635.7	313.8	321.9
Sunflower (Tins)	605.0	261.0	344.0
Millet(Tins)	7.0	2.0	5.0
Rice (Tins)	36.0	24.0	6.0
Groundnuts(Tins)	33.0	11.0	22.0
Wheat (Tins)	392.0	121.0	271.0
Pyrethrum(Kgs)	1 030.0	-	1 030.0
Round potatoes (Bags)	447.1	9.8	437.3
Sweet potatoes (Bags)	36.6	15.6	21.0
Cassava (bags)	3.0	3.0	-
<b>HOMEGARDENS</b>			
Hot pepper (Tins)	103.0	-	103.0
Sweet pepper (Tins)	45.0	-	45.0
Onions (Bags)	131.5	0.5	131.0
Cucumber (Bags)	80.0	-	80.0
Tomatoes (Tins)	402.0	36.5	365.5
Cabbages (Bags)	15.0	2	15.0
Bananas (Bunches)	3 234	1 426	1 808
Pawpaw (Pieces)	13 663	414	13 249
Garden peas (Tins)	118	96	22.0
Carrots (Bags)	144	-	144
Avocado fruits (bags)	1 465.5	225	1 240.0
Mango fruits (Bags)	1 780.5	215.0	1 565.5
Coffee (Kgs)	5 240	-	5 240.0
Maize (tins)	1 154.5	700.0	454.5
Beans (Tins)	53.0	43.0	10.0
Lemon fruits (Tins)	544.0	10.5	533.5
Orange fruits(Tins)	52.0	28.0	24.0
Peach fruits (Tins)	826.0	100.0	726.0
Guava fruits(Tins)	45.0	45.0	-
Pruned fuel wood (Bunches)	1 422	550.0	872.0
Grevellia trees( Pieces)	11.0	3.0	8.0
Chickens (Count)	222.0	25	197
Pigs (Count)	16.0	-	16
Other livestock(Count)	107	-	107
Lvstck byproducts (litres)	16 100.0	1 196.0	14 904.0
<b>LIVESTOCK</b>			
Cattle (Count)	16	-	16
Goat ( Count)	38	5	33
Sheep (Count)	16	2	14
Byproducts Livestock (Litres)	972	560.0	412.0
Farm manure (Tones)	18.5	18.5	-
<b>FORESTRY</b>			
Timbers (Pieces)	455	-	455
Fuel wood (Pieces)	60	60	-
Building poles (Pieces)	150	-	150
<b>BUSINESS</b>			
Local brews (20lts buckets)	61	22	39
Carpentry (Tshs)	2 250 000	480 000	1 770 000
Retail shops (Tshs)	710 000	145 000	562 000
<b>EMPLOYMENT</b>			
Ward Executive Officer (Tshs)	2 940 000	1 260 000	1 680 000
Ward Agricultural Officer (Tshs)	3 000 000	1 200 000	1 800 000



**Appendix 7: Various sources and quantities of household food security and income generation between sources (Tshs/year) across Wards**

Sources/Wards	U/usongwe	Mshewe	Ijombe	Maendeleo	Mean
Homegardens	1.668*10 <sup>6</sup>	952 313	357 379	405 000	853 644
Std.deviation	2.142*10 <sup>6</sup>	1.328*10 <sup>6</sup>	4.301*10 <sup>5</sup>	4.069*10 <sup>5</sup>	1.39410 <sup>6</sup>
Agriculture	841 850	570 927	637 687	852 860	675 831
Std.deviation	2.1514*10 <sup>5</sup>	1.732*10 <sup>5</sup>	3.579*10 <sup>5</sup>	2.034*10 <sup>5</sup>	2.464*10 <sup>5</sup>
Employment	500 000	640 000	480 000	0	552 000
Std.deviation	0.000	2.263*10 <sup>5</sup>			1.389*10 <sup>5</sup>
Livestock	320 000	551 400	247 500	143 429	302 429
Std.deviation	1.576*10 <sup>5</sup>	3.603*10 <sup>5</sup>	2.119*10 <sup>5</sup>	1.147*10 <sup>5</sup>	2.582*10 <sup>5</sup>
Forestry	221 250	131 667	203 000	174 963	182 782
Std.deviation	2.591*10 <sup>5</sup>	2.591*10 <sup>5</sup>	3.655*10 <sup>5</sup>	3.919*10 <sup>5</sup>	3.491*10 <sup>5</sup>
Business	180 667	260 000	198 000	500 000	242 889
Std.deviation	26 858	1.698*10 <sup>5</sup>	3.372*10 <sup>5</sup>	.	2.141*10 <sup>5</sup>

Significance level (p<0.05) NB; the significance was based between sources

**Appendix 8: ANOVA table of total production from various sources and quantities of household food security and income generation in Mbeya Rural District**

Sources of variation	df	Sum square	Mean square	F- value	P-value
<b>Main effects</b>					
Wards	3	3.735*10 <sup>11</sup>	1.245*10 <sup>11</sup>	1.580	0.236ns
Sources	5	1.306*10 <sup>12</sup>	2.612*10 <sup>11</sup>	3.316	0.033*
Error	15	1.182*10 <sup>12</sup>	7.877*10 <sup>10</sup> <-		
Total	23	2.286*10 <sup>12</sup>			

NB: ns-non significant \*significant, (Significance Level: 0.05)

**Appendix 9: Contribution of annual average quantities (Tshs) of various sources to household food security in the study area**

Sources	U/utengule	Mshewe	Ijombe	Maendeleo	Mean total
Agriculture	252 362	227 519	261 303	242 884	246 472
Std deviation	$2.151*10^5$	$1.731*10^5$	$3.579*10^5$	$2.034*10^5$	$2.464*10^5$
Homegardens	146 015	78 070	61 571	73 059	91 470.
Std deviation	$1.494*10^5$	58674.284	42 289	33 937	94 401
Forestry	63 000	44 167	49 647	46 074	48 509
Std deviation	56 965	36 389	33 451	37 980	37 603
Livestock	38 100	67 375	5 000	65 833	50 023
Std deviation	54 943	74 652		94 103	68 672
Business	50 000	46 000	19 000	50 000	39 000
Std deviation	0.0000	12 513	12 513		16 248
Employment Std deviation	75 000	65 000	80 000		72 000
	7 071	21 213			13 038

Significance level ( $p < 0.05$ )

**Appendix 10: ANOVA table on various sources and quantities to households food security (Tshs/year)**

Source of Variation	Degree of Freedom	Sum of square		F-value	P-value
		Type III SS	MS		
Main Effects					
Wards	3	$24.111*10^8$		$8.037*10^8$	1.181
Sources	5	$1.263*10^{11}$		$2.525*10^{10}$	37.115
Error	15	$1.021*10^{10}$		$6.804*10^8 <$	

NB: ns –non significant      \*\*\* highly significant ( $p < 0.05$ )      LSD 0.05 = 39312.9444547

**Appendix 11: Contribution of various sources to average annual income per household in Tshs/year**

Sources	U/usongwe	Mshewe	Ijombe	Maendeleo	Mean total
Homegardens	1.007*10 <sup>6</sup>	652 310	252 815	233 536	548 181
Stddeviation	1.189*10 <sup>6</sup>	1.177*10 <sup>6</sup>	3.715*10 <sup>5</sup>	3.116*10 <sup>5</sup>	9.301*10 <sup>5</sup>
Agriculture	507 500	269 223	517 027	517 027	422 992
Stddeviation	1.374*10 <sup>6</sup>	2.401*10 <sup>5</sup>	8.517*10 <sup>5</sup>	6.834*10 <sup>5</sup>	8.880*10 <sup>5</sup>
Forestry	221 250	131 667	203 000	174 963	182 782
Stddeviation	1.576*10 <sup>5</sup>	1.301*10 <sup>5</sup>	3.655*10 <sup>5</sup>	3.919*10 <sup>5</sup>	3.491*10 <sup>5</sup>
Livestock	320 000	535 400	247 500	153 333	309 350
Stddeviation	1.576*10 <sup>5</sup>	3.855*10 <sup>5</sup>	2.119*10 <sup>5</sup>	1.109*10 <sup>5</sup>	2.624*10 <sup>5</sup>
Business	180 667	260 000	198 000	500 000	242 889
Stddeviation	268 588	1.698*10 <sup>5</sup>	3.371*10 <sup>5</sup>	0.000	2.138*10 <sup>5</sup>
Employment	500 000	640 000	480 000		552 000
	0.0000	2.263*10 <sup>5</sup>	.		1.389*10 <sup>5</sup>

Significance level (p<0.05)

**Appendix 12: ANOVA table on various sources and quantities to household income generation**

Source of variation	Degree of freedom	Sum of square	Mean squares	F-value	P-value
Main Effects					
Wards	3	1.642*10 <sup>11</sup>	5.474*10 <sup>10</sup>	1.234	0..3323 ns
Sources	5	3.063*10 <sup>11</sup>	6.128*10 <sup>10</sup>	1.381	0..2864ns
Error	15	6.657*10 <sup>11</sup>	4.438*10 <sup>10</sup> <-		
Total		231.136*10 <sup>12</sup>			
NB: ns-non significant		*significant, (P <0.05)	LSD 0.05 = 317 516		

**Appendix 13: Household food shortage experience in two consecutive years across wards of the respondents**

<b>Items</b>	<b>U/utengule</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Total</b>	<b>Percent</b>
Yes	13	13	18	17	61	51
No	17	17	12	13	59	49

**Appendix 14: Period of household food shortage experience in a year**

<b>Months of food shortage</b>	<b>Ward of the respondent</b>					<b>Total N=120</b>	<b>Percent</b>
	<b>U/utengule</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>			
One	2	0	1	0	3	5	
Two	4	8	10	7	29	51	
Three	4	3	1	7	15	26	
Four	0	0	3	2	5	9	
Five	1	1	2	1	5	9	
<b>Total</b>	<b>11</b>	<b>12</b>	<b>17</b>	<b>17</b>	<b>57</b>	<b>100</b>	

**Appendix 15: Summary for seasons that households/ward experienced food shortage in a year**

<b>Seasons</b>	<b>U/utengule</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Total</b>	<b>Percent</b>
Off season	0	2	0	0	2	2
Planting season	11	10	17	17	55	46
<b>Total</b>	<b>30</b>	<b>30</b>	<b>30</b>	<b>30</b>	<b>120</b>	<b>100</b>

**Appendix 16: Coping strategies for household food security in the study area**

<b>Strategy</b>	<b>U/utengule</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>maendeleo</b>	<b>Total</b>	<b>Percent</b>
Buying food	4	5	13	8	30	25
Casuallabourers	5	3	4	8	20	17
Remittances	0	1	0	0	1	1

**Appendix 17: Reasons for household food shortages in Mbeya Rural District**

<b>factors for yield decrease</b>	<b>U/usongwe</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Total</b>	<b>Percent</b>
Low capital	14	11	16	6	47	34.3
High inputs prices	6	10	11	3	30	21.6
Unreliable rainfall	3	6	6	4	19	13.6
Subsidy fert. delay	0	7	2	5	14	10.2
Sickness	0	2	2	3	7	5.1
Pests and diseases infestation	0	0	0	6	6	4.4
Poor crop rotation	0	0	0	6	6	4.4
Land degradation	0	2	2	2	6	4.4
Too much rainfall	0	0	0	1	1	0.7
Poor technologies	0	0	0	1	1	0.7

**Appendix 18: Factors that motivated people to use homegardens technologies to household food security and income generation in Mbeya Rural District**

<b>Roles of using</b>						<b>Percent</b>
<b>Hmgdns</b>	<b>U/Usongwe</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Frequency</b>	
Sufficient food	15	13	24	19	71	41.5
Getting income	22	6	26	7	61	35.7
Having diverse products	7	8	8	5	28	16.4
Help in soil conservation	0	1	0	0	1	4.1
Help in shade provision	0	2	1	0	3	1.8
Life risks reduction	2	3	0	2	7	0.5
<b>Total</b>	<b>46</b>	<b>33</b>	<b>59</b>	<b>33</b>	<b>171</b>	<b>100.0</b>

**Appendix 19: Factors limiting the contribution of Agroforestry homegardens to household food security and income generation**

<b>Factors</b>	<b>U/utengule</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Frequency</b>	<b>Percent</b>
Crop competition	12.3	15.4	10.8	10.8	49.3	31.9
Low yields	1.5	9.2	7.7	3.1	43.0	27.8
Low capital	10.8	1.5	7.7	7.7	27.7	17.9
Unreliable market	1.5	1.5	4.6	4.6	12.2	7.9
Low crop prices	0.0	4.6	3.1	3.1	10.8	6.9
Land shortage	1.5	3.1	1.5	1.5	7.6	4.9
Shortage irrigation water	1.5	1.5	1.5	0.0	4.5	2.9
Conflict to neighbors	1.5	0.0	1.5	0.0	3.1	2.0
Lack of improved cultivars	0.0	1.5	0.0	0.0	1.5	1.2
Insufficient time in hmgdns	1.5	0.0	0.0	0.0	1.5	1.2

**Appendix 20: Land size and land acquisition**

<b>Information/item</b>	<b>u/usongwe</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Total</b>
<b>Land ownership</b>					
Owned land	30	30	30	30	120
Not owned land	0	0	0	0	0
<b>Extra land acquisition</b>					
hired	13	17	16	11	57
bought	2	1	0	1	4
Given by village govt	1	0	0	0	1
<b>Land size owned</b>					
0.25-3 acres	16	21	29	24	90
3.5-10 acres	14	8	1	6	29
>10 acres	0	1	0	0	1

**Appendix 21: Distribution of frequency on respondents' knowledge access in the study area**

<b>Information item</b>	<b>Percent</b>
<b>Agric. education training</b>	
Attended	31.4
Not attended	68.6
<b>The importance of hmgdns technologies</b>	
Important	70.1
Not important	29.9
<b>How you learnt hmgdns technologies</b>	
From neighbors	7.5
From agricultural officers	13.3

**Appendix 22: Respondents on market facilities in the study area**

<b>Products selling</b>	<b>Percent</b>
farm gate	85.8
distance market	14.2



**Appendix 23: Measures to be taken in improving the contribution of homegarden technologies to food security and income generation in the study area**

<b>Types of measures</b>	<b>U/usongwe</b>	<b>Mshewe</b>	<b>Ijombe</b>	<b>Maendeleo</b>	<b>Frequency</b>	<b>Percent</b>
credit provision	8	11	9	6	34	25.6
Knowledge	10	7	9	5	31	23.3
Earlier subsidy fertilizers provision	1	5	6	10	22	16.5
fertilizer prices reduction	3	4	6	2	15	11.3
Fertilizer subsidies to all sellers	3	3	7	1	14	10.5
Market provision	1	2	2	3	8	6.0
demonstration plots	1	0	2	0	3	2.3
Type of tree selected	1	0	1	1	3	2.3
Infrastructure (transport)	1	0	0	1	2	1.5
land separation	0	1	0	0	1	0.8
<b>Total</b>	<b>29</b>	<b>33</b>	<b>42</b>	<b>29</b>	<b>133</b>	<b>100.0</b>