ROLES OF LOCAL INSTITUTIONS ON THE PERFORMANCE OF CHAGGA HOMEGARDEN IN KILIMANJARO REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN LAND USE PLANNING AND MANAGEMENT OF SOKOINE UNIVERSITY OF AGRICULTURE MOROGORO, TANZANIA.

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ABSTRACT

The Chagga homegarden agroforestry system is a multi-storeyed land use system evolved over several decades through a gradual transformation of the natural forest on the footslopes of Mount Kilimanjaro. Chagga homegardens have been declining steadily over the years, a trend that is likely to continue for some foreseeable future. Thus the cross sectional study design was employed during September 2012- May 2013 to assess the roles of local institutions on the performance of Chagga homegarden and explore sustainability of this system. Socio-economic, institutional and spatial data were collected using semi structured questionnaires together with checklist during focus group discussion. The spatial data were analyzed by using ERDAS Imagine 2011 and ArcGIS 10.0 software program. Qualitative data were analyzed using content analysis while descriptive and inferential statistic analyses were applied using SPSS version 16.0. In evaluating homegarden performance, Ordinary Least square method of regression was used to assess the effects of social economic factors on the production performance of Chagga homegarden. The findings indicate that leadership, conflict resolution, land and livestock based, health and beliefs and recreational institutions exist which seem to relate directly or indirectly to management of Chagga homegarden. Despite the advent of modernity and formal institutions, informal institutions remain relevant to performance of Chagga homegarden. The Chagga homegarden has undergone some changes which resulted into land cover change between 1987-1995 and 1995-2013. Homegarden cover decreased by 70.42% in 1995-2013 a trend that is likely to lead to disappearance of homegardens in some foreseeable future. Education level, access to extension services and number of milked cow were the socio-economic factors found to enable the production performance while distance to the market and small businesses were factors constraining the production performance of Chagga homegarden. Encouraging interaction

between formal and informal institutions in management of Chagga homegardens together with proper promotion of homegarden land use systems will ensure sustainability of the Chagga homegardens.

DECLARATION

I **Naomi Adoncome Mcharo,** 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 concurrently being submitted for a degree award in any other institution.

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DEDICATION

This work is dedicated to my dearly loved husband Abel Mtembeji and our kids Yvonne, Elnathan and Ethan.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBOs	Community based organizations
CCM	Chama Cha Mapinduzi
CEC	Cation Exchange Capacity
CPR	Common Pool Resources
DALDO	District Agricultural and Livestock Development Officer
ELCT	Evangelical Lutheran Church in Tanzania
ICRAF	International Center for Research in Agroforestry
MKUKUTA	Mkakati wa Kupambana na Kupunguza Umasikini Tanzania
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
NAFCO	National Agriculture and Food Cooperation
NBS	National Bureau of Statistics
NGO's	Non-Government Organisations
NRM	Natural Resource Management
TEACA	Tanzania Environmental Action Association
KNCU	Kilimanjaro Native Co-operative Union
KIWAKABO	Kikundi cha Wakulima wa Kahawa Bora
SACCOS	Serving and Credit Cooperative Society
TLP	Tanzania Labour Party
UN	United Nation
UNCED	United Nations Conference on Environment, Development

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Indigenous agroforestry system practiced for many decades have been documented in Tanzania (ICRAF, 2004). Some of these land use systems that have drawn scientists' attention include traditional agroforestry system on the slopes of Mt. Kilimanjaro known as *Chagga homegardens (kihamba)* (Soini, 2002; Fernandes *et al.*, 1984), Mara region homegardens known as *Oboliochere* (Kitalyi, 2004), Kagera region homegardens known as *Kibanja* (Kitalyi and Soini, 2004), and Wasukuma silvopastoral system found in Shinyanga called *Ngitili* (Kamwenda, 2002).

The Chagga homegarden agroforestry system is a multi-storeyed land use system that has evolved over several decades through a gradual transformation of the natural forest on the footslopes of Mount Kilimanjaro into homegardens (Soini, 2002). It is a unique system and highly integrated with a rich biodiversity (Kitalyi and Soini, 2004). Sustainability of the system has partly been made possible by the existence of a network of canals of varying length and capacities that have been used for irrigation purposes (Hemp, 2006).

Furthermore stability of this system in the past has been attributed to reliable rainfall, fertile volcanic soils, good vegetation cover and a well-managed system under the Chagga informal or local institutions (rules, customs and norms) (Kitalyi and Soini, 2004). However over the years the Chagga homegardens have been declining steadily a trend that is likely to continue for some foreseeable future (Lambrechts *et al.*, 2002).

Diminishing water resources is probably the most dramatic change in the Chagga area. Farmers have noticed the reduced water supply due to a number of factors. Climate change had an impact in the area with the disappearance of 75% of glaciers on Mt. Kilimanjaro since 1912 (Soini, 2002). Change of indigenous vegetation to exotic species in the homegarden area, and cultivation of the immediate riverbanks is believed to have contributed to the drying up of rivers and springs (Kitalyi, 2004). According to Soini (2003) the Chagga homegarden land use system is under pressure due to socio-economic changes that are taking place worldwide (political, economic and market conditions). Population pressure and the land tenure system among the Chagga communities have led to land fragmentation and consequently decline in production. Land scarcity hinders both expansion of cultivation and animal husbandry hence reducing the economic viability of the homegardens (Mhando and Mbeyale, 2010).

Epaphra (2001) who conducted an assessment of the role of women in agroforestry systems at Marangu and Mamba, in Kilimanjaro Region, Tanzania showed that women have no control over land though they are the ones who perform a decisive role in agroforestry production. Women contribution to various activities is restricted to marketing of what they have produced. Fluctuating world market prices and the rise of production costs for coffee, have forced many farmers to shift from coffee production to other income generating activities (Lambrechts *et al.*, 2002). Under such circumstances, formal institutions together with local institutions would be expected to play a leading role in the regulation of market, economy as well as production factors, so as to avoid policy and market failures (Young, 1990). Therefore the need for a better understanding of how well local institutions have worked in the past and how strategies can be fostered to integrate aspects of traditional governance system into the formal system forms the basis of the present study.

Mwakatobe (2001) studied the importance of homegardens on beekeeping activities in Arumeru, Arusha, Tanzania and found that the components of homegardens are highly interrelated and jointly play a significant role in promoting and sustaining beekeeping. Unlike the present study the focus was on homegardens to sustain beekeeping and lack information on institutional factors for sustainability hence required supplemental study. The present study aims to extend the documentation by focusing on the overall local institutions and its contribution to homegarden sustainability.

Development of Chagga homegardens depends on effectiveness of institutions managing them. Institutions are important for mobilizing resources and regulating their use with a view to maximize production (Mowo *et al.*, 2011). They can be seen as sets of formal and informal (local) rules that shape interactions between humans and nature (North, 1990). They define who controls the resources, how conflicts are resolved, and how the resources are sustainably managed and exploited (Richards, 1997). Mbeyale *et al.* (2009) in his study on institutional changes in management of common pool resource (CPR) in Eastern Same, Tanzania attributed an increase of resource use conflict to institutional changes. Ostrom (1990) argues that the best way to manage a complex system such as a drainage basin is to look for a synergy between ecosystem services and different land uses with all the interconnections. Mbeyale *et al.* (2009) recommends an ecosystem based institutional framework that is capable of accommodating institutional changes while improving people's welfare and sustainable management of CPR. Institutions crafted in this way have a better chance of sustaining the resource base and at the same time providing the needs for all possible beneficiaries. Therefore to understand the roles of local institutions in conjunction with homegarden performance is of vital importance for the sustainability of the system and avoiding dispute.

According to Mowo *et al.* (2011) a variety of local institutions involved in natural resource management that exist in the Baga watershed in Lushoto District (North-eastern Tanzania) have diverse functions and relate directly or indirectly to natural resource management. It is recognized that in order to balance livelihood and conservation objectives, it is essential to engage local communities in the management of natural resources. For successful engagement of local communities, project implementers need to recognize and work with local institutions. This is because of their role as custodians of local knowledge (Donnelly-Roarck *et al.*, 2001), in mobilizing collective action (Gupta, 1992; Olate, 2003) and connecting members of different communities (Donnelly-Roarck *et al.*, 2001) all of which are fundamental to effective NRM. This study intended to assess the roles of local institutions on the performance of Chagga homegarden in Kilimanjaro Region, Tanzania so as to explore the possibility of sustaining this agroforestry system.

1.2 Problem Statement and Justification of the Study

Chagga homegarden land use system as part of traditional agroforestry system is well suited to contribute to the desired outcomes of Tanzanian National Strategy for Growth and Reduction of Poverty (MKUKUTA) launched in 2006. The prime objective of research and development on this system has for years been to increase food production, provide raw materials and raise cash income. Similarly, Chagga homegarden allows farming families the opportunity to integrate trees into their farms, enhancing diversity and increasing overall productivity without taking agricultural land out of production and consequently help to achieve the Millennium Development Goals (Kitalyi, 2004).

Sustainable management of the Chagga homegarden land use system is a major concern because of the diversity of products emanating from it and the impending threats to natural resources due to increasing human population. Several key policy aspects and questions about which strategies to pursue for Chagga homegarden development remain

unanswered mainly because of inadequate research on the roles of local institutions on performance of the system. On-farm technological options should be supported by local institutional and policy aspects which will provide an enabling environment for the development of Chagga homegarden land use system (ICRAF, 2004).

Institutions play a central role in facilitating livelihood outcomes which include more income, improved well-being, reduced vulnerability, improved food security and more sustainable use of homegarden resources (Carney, 1998). Through this study understanding the roles of local institutions on the production performance of Chagga homegarden land use system is undeniably vital for a wide spectrum of actors; to give researchers the better insights about the past situation, current scenarios and future attentions/directions, to help policy makers during formulation of policies to integrate aspects of traditional governance system into the formal system, to help extension agents plan their activities whilst avoiding land degradation and other advocates of land including the progressive farmers for developing management strategies and recommendations for maximizing indigenous agroforestry production.

1.3 Research Objectives

1.3.1 Overall objective

To assess the roles of local institutions on the production performance of Chagga homegarden in Kilimanjaro Region.

1.3.2 Specific objectives

i. To examine local institutions responsible in managing the Chagga homegardens
ii. To examine the status of land uses characterizing Chagga homegardens
iii. To determine socio-economic factors affecting the production performance of Chagga homegardens

1.4 Research Questions

The study was undertaken using the following questions:

i. What are the local institutions responsible in managing Chagga homegardens?
ii. How do land use change in the study area?
iii. How do land use change influenced by local institutions?
iv. What are socio-economic factors affecting the production performance of the Chagga homegardens?
v. How do socio-economic factors influenced by local institutions?

1.5 Conceptual Framework

The historical, political, economic and biophysical context and trends represent the drivers of change within which local livelihoods and land use practices are nested, and with which livelihoods and land use practices interact through both long-term trends and short-term disturbances (shocks and surprises). The interaction is not a one-way exchange from the macro to the micro level of institutions as indicated by the two-way arrows connecting local livelihoods and land use (Figure 1).

Local institutions at various scales mediate the allocation and use of homegarden resources by people. They determine the ways in which the external context and trends influence local livelihoods and therefore patterns of resource use which affects ecosystem change. Local institutions strengthen and weaken through interactions with factors outside of the local context and are constantly negotiated and readjusted through a process of social learning and adaptation in response to changes in the local environment and through interactions with the wider social-ecological environment.

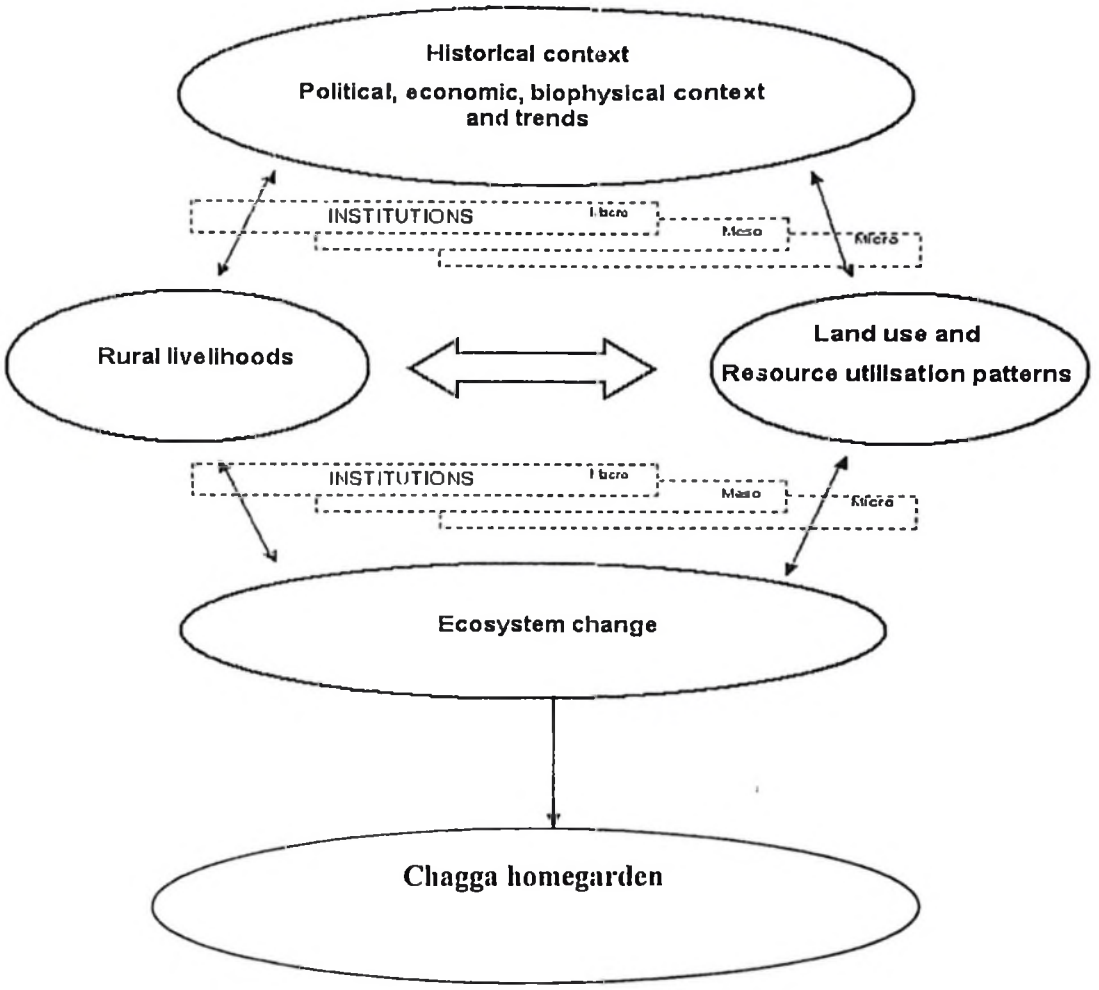


Figure 1: Conceptual framework modified from Cundill (2005).

1.5 Organisation of the Dissertation

This dissertation is organized into five Chapters. The first Chapter is an introductory part, which gives a broad overview of the study. Chapter two is a review of relevant literature. The third Chapter presents the methodological part used in data collection and analysis, while Chapter four is a presents results and discussion of these results. The fifth Chapter gives the conclusion and recommendations of this study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Land Use

De Sherbinin (2002) defines land use as the term that is used to describe human uses of land, or immediate actions modifying or converting land cover. Land use is a crucial link between human activities and the natural environment. It is an outcome of natural and socio – economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare.

Large parts of the terrestrial land surface are used for agriculture, forestry, settlements and infrastructure. Land use is the most important factor influencing biodiversity at the global scale (Sala *et al.*, 2000). Global biogeochemical cycles (McGuire *et al.*, 2001), freshwater availability and climate (Brovkin *et al.*, 1999) are influenced by land use. Closing the feedback loop, land use itself is strongly determined by environmental conditions. Climate (Mendelsohn and Dinar, 1999) and soil quality affect land-use decisions. For example, they strongly influence the suitability of land for specific crops and thus affect agricultural and biomass production (Wolf *et al.*, 2003).

2.1.1 Land use and land cover dynamics and links

Land cover refers to the natural vegetative cover types that characterize a particular area. Land-use change is the proximate cause of land-cover change. The driving forces to this activity could be economic, technological, demographic, scenic and/ other factors. Hence,

land use and land cover dynamics are a result of complex interactions between several biophysical and socio-economic conditions which may occur at various temporal and spatial scales (Reid, 2000). Land cover has gone under continuous change for millennia. This is because human's production demands cannot be fulfilled without modification and/or conversion of land covers. In the past two centuries, the impact of human activities on land has grown enormously because of population increase, technological development and the requirements thereafter, altering entire landscapes, and ultimately impacting the biodiversity, nutrient and hydrological cycles as well as climate (De Sherbinin, 2002) especially in the developing world. These diverse roles have been recognized in a large number of research publications and international conferences, symposia, and workshops devoted to the subject over the past few years.

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes (Reid and Wilson, 1985). The advancement in the concept of vegetation mapping has greatly increased research on land use/land cover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources. Among others, the three international conferences on Human and the Environment held in Stockholm in the year 1972 followed by United Nations Conference on Environment and Development (UNCED) which took place in Rio de jeneiro in the year 1992 and the World Summit for Sustainable Development in Johannesburg the year 2002, called for substantive studies of land-use and land-cover changes and since then it has become a global issue (Reid and Wilson, 1985). This is because the effects of land-use and land-cover are directly related to the livelihoods of people. According to Pimentel (1993), as cited in Bewket (2003), for almost all food requirements, people of the world totally depend on land resources, except for only 3% of the food which is coming from aquatic

resources. Therefore, this important resource needs careful management for the sake of sustained ability to feeding the world population. Even though, natural processes may also contribute to changes in land cover (Allen and Barnes, 1985).

2.1.2 Land tenure system and land reforms in Tanzania

According to the study conducted by Myenzi (2009) the land tenure system of Tanzania has passed through different historical milestones which form the basis for the analysis of the land tenure regime in general and tenure relations for land owners and users in particular in the past eight decades. The history dates back to 1923 when the British colonial legislative assembly enacted the Land Ordinance cap 113 to guide and regulate land use and ownership in Tanganyika which was their protectorate colony (Myenzi, 2009). Prior to this law, all the land in Tanzania was owned under customary tenure governed by clan and tribal traditions. Ideally, elders of respective clans and tribes were bestowed with powers to determine land allocations and resolve conflicts whenever they arose.

When the 1923 land law came into force, it ideally imposed radical changes on the land ownership and use pattern that existed prior to colonialism. The noble arrangements in the local land administration systems were disrupted and traditional institutions replaced with colonial machinery that had little regard on the rights to land of the colonial subjects. It also stated that, all the land in Tanzania and the use rights were under the control of the British Governor and that any use must be subject to the will and permission of the Governor. This was virtually a transfer of ownership and control over land from the people to one person, the Governor. In order to reinforce administrative decisions, a new form of ownership through granted rights of occupancy was introduced. Although the deemed rights of occupancy that the natives enjoyed were not dissolved by this law, the

actual practice revealed big differences in realization of the two sets of occupancy rights. Deemed rights were considered to have low value and un-enforceable unlike the granted rights which one could prove by just a show of title deed or certificate. Thus between 1920's and 1960's when Tanzania got her independence, the natives who owned land customarily experienced loss of their lands to the colonial state in favor of introduction of commercial farm estates. Those whose land was alienated were forced to become casual laborers in the estates.

Land use change on Mount Kilimanjaro has also been influenced by Government policies and legislations, which date back to 19th century. The policies and legal frameworks introduced by colonial governments since 1898 led to alienation of land for European settlements, large scale farms and ranches, making it unavailable for the local population. This affected the distribution of land and reduced the land available to the local population for cultivation and grazing. The colonial agricultural policies, which encouraged the introduction of coffee and establishment of large scale coffee estates in the 1930's not only disrupted pre-existing land use but also led to significant land use and cover changes (Soini, 2005). For example, pastures above the inhabited area as well as share of the homegardens reserved for animal grazing were taken over for coffee growing, with extensive grazing giving way to stall feeding indoors (Maro, 1988). Coffee plantations also replaced nearly all the remaining forest leaving few shade trees, mainly *Albizia schimperiana* and *Rauvolfia caffra* (Devenne *et al.*, 2006).

2.1.2.1 Land reforms after independence

Tanzania got independence in 1961. However, no significant changes were made on the land tenure regime. The only notable change made was the replacement of the word *governor* with *president*. The law also clearly stated that, all the land in Tanzania is public

but vested to the president on behalf of all the citizens. Ideally, this notion entails that the president should be the custodian of the people's property which includes land. However, vesting radical title in the presidency has over time revealed grave problems as the powers have either been misused or abused by the executive arm of the state which virtually reinforces presidential powers. Cases of land acquisition and disposition without compensation filled up the court registries throughout 1970's to 1990's. Most of the cases were filed by ordinary villagers versus the state which was behind all the moves for land alienation and acquisition. The famous Mulbadaw case in which Yoke Gwako and Aku Gambul and 67 other villagers took over NAFCO and the government to court objecting acquisition of Bassoutu complex grazing plains is a good case in point. The battle extended from courtrooms to villages and reserved estates where endless disputes emerged between various land users for different reasons. In all the deals, the state and its agents were behind both as cause and sympathizers or arbiters whenever problems arose.

Various laws and declarations were also enacted during this period to reinforce decisions in land administration such as the Land acquisition Act number 47 of 1967. This gave the president powers to acquire land in any part of the Republic of Tanzania for the so called national interest. Much as this sounds good for national development, the so called national interest was by then, vaguely defined as to include alienation of people's land to establish state owned corporations some of which had little link if any with local people's wellbeing. National interests were actually expanded in the nineties to include almost everything without forgetting pushing away villagers from their land and re-allocating the same to a foreign investor even if the latter is given such land for free in addition to five years tax holiday as incentives.

Other laws included the 1967 Arusha Declaration, the Village and Ujamaa village Act of 1975, the Land regularization Act of 1982 and the Local Government District Authorities Act number 7 of 1982. All these acts of parliaments and laws had a bearing on the rights to land of majority small producers but didn't transform the land tenure system into a better form than the previous one. The Arusha declaration for example, was a blue print for a new turn in national development where all the major means of production had to be owned and managed by the public to bring about equality in the access to and ownership of national resources and services.

Despite the good intentions however, it has always been on record that implementation of programmers and projects in the post Arusha declaration era, was associated with gross violations of land and human rights especially for rural based small producers. Villagers were moved from their old settlements to new Ujamaa villages throughout 1970's but this also meant loss of their old means of living and sources of livelihoods especially for those who were moved to semi-arid and less arable lands. To make it worse, the land acquisition act of 1967 was purposely enacted to empower the president acquire land from anybody for the so called public interest which critics have maintained that it amounts to misuse of presidential powers than serving public interests because the latter finds no legality in the books of laws . Even the justified compensation has never been left free of criticisms as experience and practice have gathered complaints from recipients that it is neither commensurate with the value of the land and properties acquired nor based on principles of fair and justice.

In Kilimanjaro the post-independence policies, including the Villagisation policy, the 1983 Agricultural policy and the Labour Deployment Act of 1983 led to the resettlement of people and expansion of agriculture in the lowlands.

2.1.2.2 Recent land reforms and their implications

The 1990's land reforms mark a very significant turning point in the development and administration of land tenure system in Tanzania. This is a time when the land administration system was dominated by serious problems of corruption, mal administration, grabbing of poor people's land by the rich and political elites, alienation and eviction of small land holders out of their lands for private interests, etc. Those problems called for major transformation in both the administration and management of land issues. In response to the looming public outcries, a presidential Commission of inquiry into land matters was established in 1991. This made a very comprehensive search of public views and opinions throughout the country and recommended for alternative land tenure system that would take into consideration the values, interests and rights of all the groups in a socially just and equitable manner.

However, the National land policy of 1995 and the land acts of 1999, (Land Act number 4 and village land act number 5) selectively espoused the recommendations leaving out fundamental issues that formed the basis of the commission findings. For instance, the commission had proposed that the radical title be decentralized away from the president to the lower organs of people's representation like the village assemblies, district councils and national Assembly but this has never been the case despite the efforts from the civil society to push for the reforms.

Secondly, the commission had also recommended that land be made a constitutional category as means to enhance security of tenure. It was argued, it would be easier to manage a constitutional reform with public support than a mere act of parliament which experience has shown that it can sometimes be passed by simple majority in the house or under certificates of urgency even when it doesn't reflect the interest of the people.

This again is merely echoed in the National Land Policy but does not appear anywhere in the land laws.

The third biggest recommendation was with regard to land administration. The commission had proposed that participatory land administration machinery parallel to the state bureaucracy be established. This would help resolve some of the chronic problems in the land tenure that emanate from archaic governance structure of the state. Again, this met with a lot of resistance and was thrown out. That is the reason why the new land laws have always been criticized as pieces of legislation that have to the greatest extent, jeopardized security of tenure of majority small producers especially rural peasants and pastoralists while embracing the rights for well connected people in society who either come in as investors or purchasers of land from the poor.

2.1.2.3 Salient features of the recent land reforms and their implications

The driving force behind recent land reforms in Tanzania which appears to cut across the entire East African region is the commercial interests that capitalize on commoditizing land to attract foreign investors. As said earlier, Tanzania land act was enacted in 1999 as Land Act number 4 of 1999 for general land and Village land Act number 5 of 1999 for village land. The preamble and main principles of both the land laws and National land policy indicate that land has value and must be used to serve more commercial interests than the subsistence value it has always contained. Given the fact that majority rural based small producers depend on land for their subsistence like food security and related use, they are subjected to vagaries of the market where their survival becomes at stake. That became vivid in the recent amendments that have been made on the land act number 4 of 1999 in early February 2004 which spelt out the objects of the reform as to ease and facilitate land marketing and mortgaging, allow for sale of bare land and soften conditions

for foreigners to invest on land. The amendments have for the first time in the history of Tanzanian land tenure system, attached commercial value on land and authorized sale of land without unexhausted improvements which was previously prohibited to protect majority customary and small land users' rights. This will obviously bear far reaching implications in the near future as the value of land keeps on appreciating while its size remains intact. Economically, this is a simple arithmetic, that when the demand is high and the supply is low the prices automatically go up. Land price will rise far higher than the ability of majority rural based producers to afford. That is only one but there are many other effects linked to this including food insecurity.

2.1.3 Agroforestry as land use system

Agroforestry refers to land-use systems in which trees or shrubs are grown in association with agricultural crops, pastures or livestock, and in which there are both ecological and economic interactions between the trees and other components. (Young, 1990). It covers combinations of trees with plants or animals, and that there must be interactions between the tree and non-tree parts of the system.

King (1978) defined Agroforestry as a sustainable land management system which increases the overall yield of the land, combines the production of crops and forest plants and/or animals simultaneously or sequentially on the same unit of land, and applies management practices that are compatible with the cultural practices of the local population. Within agroforestry conservation of landscape biodiversity is enhanced and rural incomes are diversified and sustained (Noble and Dirzo, 1997).

Agroforestry improves the productivity of agricultural systems, while also diversifying the products from the system. Ultimately use of the system leads to food security, soil and

water conservation, and long-term sustainable agriculture (FAO, 2004). It has the potential to reduce risk through diversification of a variety of products, including food, fuel wood and animal fodder. Nutrient and water use efficiencies, reduction of nutrient leaching to groundwater and improve soil physical and biological properties are some of the attributes of agroforestry (Huxley and Ranasinghe, 1994).

Agroforestry practices can provide significant amounts of fuel wood. For example fuelwood production in the *Chagga* home gardens of Tanzania is estimated at 1.5-3 m^3 ha^{-1} $year^{-1}$. Assuming a minimum consumption of 1 m^3 $adult^{-1}$ $year^{-1}$ and if each family requires 4-6 m^3 $year^{-1}$, a home garden supplies 25 - 33% of the household fuelwood requirements (Fernandes *et al.*, 1984).

Studies have also shown that trees grown in contour strips, rotational woodlots and fallows can produce large quantities of fuel wood (Table 2). For example, *Grevillea robusta* trees planted on contours on an average farm size of 1.64 ha in parts of Tanzania could meet the entire annual household demand for fuel wood (Mwihomeke and Chamshama, 2004).

2.1.4 Agroforestry in Tanzania

Agroforestry research and development work in Tanzania has been going on for more than 30 years. National institutions, including research centers and universities, have conducted trials to screen exotic and indigenous tree and shrub species for suitability of different agroforestry technologies. Nyadzi (2004) research on nutrient and water dynamics in rotational woodlots found that, rotations of trees and crops on farms are considered as a potential technology to overcome the shortage of wood, reverse deforestation of natural forests and improve soil fertility for food security enhancement in

western Tanzania. However, overexploitation of soil water resources and depletion of soil nutrients have been suggested as possible negative effects of growing trees on farms in the semiarid tropics which undermine and even threaten a successful implementation of the woodlot technology at larger scale. Evidently, without proper understanding of the interactions and possible competition between trees and crops, the potential benefits of this agroforestry technology will not be realized. The significance of rotational woodlots in improving soil fertility is limited by substantial accumulation of nutrients mined by wood whereby is a major threat for the sustainability of woodlots.

Over the past 20 years, the World Agroforestry Centre (ICRAF), collaborating with national research institutions, government extension services, NGOs and CBOs, has developed several technologies that now benefit thousands of farmers in Kilimanjaro, Shinyanga and Tabora Regions. Proven technologies include: fertilizer trees and biomass transfer for soil fertility improvement, rotational woodlots, indigenous and exotic trees for food and health security, trees for livestock feed and trees for reclamation and enrichment of traditional land use systems. These technologies are already transforming lives in many parts of the country.

2.2 The Chagga Homegarden

The Chagga homegardens are a multi-storeyed traditional agroforestry system on the southern and eastern slopes of Mt. Kilimanjaro. These have evolved over several centuries through a gradual transformation of the natural forest on the footslopes of Mt. Kilimanjaro into agroforestry gardens (Hemp, 2006).

Fernandes *et al.* (1984) describe a Chagga homegarden has an average size of 0.68 ha and integrates numerous multipurpose trees and shrubs with food crops, and stall-fed animals,

with random and dense arrangement. Vertically, the following 4 stories or canopies can be distinguished: (1) food crops: taro, beans, vegetables and fodder herbs or grasses (2) coffee: 500-1400 plants/ha (3) banana: primary crop; 50% cover; 330-1200 clumps/ha and (4) trees, such as *Cordia abyssinica, Albizia schimperiana* and *Grevillea robusta.* The trees has some advantages as they provide shade for coffee, act as live fences, provide medicines, firewood, fodder, mulching material, bee forage and pesticidal properties (e.g. *Rauwolfia caffra*).

Hemp (2006) described natural flora, vegetation and structure of the Chagga homegardens and investigate the function of the Chagga homegardens as a habitat of endangered and endemic grasshopper species. Chagga homegarden land use system maintains a high biodiversity and is sustainable way of land use that meets several different demands. High demands of wood endanger the effectiveness of Chagga homegarden. It can be estimated that a homegarden supplies ¼ to ⅓ of the fuelwood requirements (Hemp and Hemp, 2008).

2.2.1 History of Chagga homegarden

Humans have continuously inhabited the slopes of Mt. Kilimanjaro for the last 2000 years. However, during the last decades the human population increased dramatically and it is estimated that the population on the mountain has multiplied 10 times within 90 years, from 1913 to 2002 (Hemp and Hemp, 2008). Most of the population is concentrated at an altitude between 1000 and 1800 meters, with densities varying from 500 to 1000 people per km^2 in some areas. Over the years, the inhabitants of the highlands in Kilimanjaro region have traditionally developed and refined a most unique farming system well suited to the local conditions. The system is known as the Chagga home garden or the *Kihamba* system (Fernandes *et al.*, 1984). It is believed that the first

homegardens and traditional water canals existed already in the 12th century. This old land use system has formed the identity of the Chagga, who are of multi-ethnic origin, despite the fact that they belong to the Bantu people (Hemp and Hemp, 2008).

By 1984, the Chagga home gardens were estimated to cover 120 000 ha on the southern and eastern slopes of Mt. Kilimanjaro mainly between 900 and 1800 m above sea level, stretching on the climatically most favourable zone of the southern and south-eastern slopes This required the existence of an institutional framework to govern the use and management of the Chagga home gardens. The homegarden has been sustaining natural resources and the livelihoods of people on the mountain Kilimanjaro for many years. However, recently the sustainability of this system has been greatly affected by the increasing population pressure, lower economic returns of coffee once the backbone of the household economy, eroding traditions, ageing farming communities and climate change.

2.2.2 Structural features of the Chagga home garden

Figure 2 is a typical Chagga home garden. The word homegarden has been used loosely to describe diverse practices, from growing vegetables behind houses to complex multi-storied systems of trees/shrubs, crops and/or livestock (Bekele-Tesemma, 2007). The term is used here to refer to an intensive cropping system that involves the integration of several multi-purpose trees and shrubs with food and cash crops and livestock on the same unit of land. These components are managed as a single unit (system) using the family labour. Within the cropping system, several agro-forestry practices can be identified, including the use of multipurpose trees and shrubs to provide shade for coffee, fodder, timber and firewood and as live fences.

Figure 2: A typical Chagga homegarden in Tema village consisting of a mixture of coffee, yams, vegetables, banana, trees (*Grevillea robusta, Albizia gummifera*) and fodder grass.

(Photo taken in January, 2013)

The Chagga homegarden is a typical agrisilvicultural system characterized by a multilayered vegetation structure similar to a tropical montane forest with trees, shrubs, lianas, epiphytes and herbs as shown on the plate above. This forest-like structural arrangement of plants mainly consists of the shade trees, the major cash crops coffee (*Coffea arabica*) and banana grown for food and sale. In order to meet their shade requirements, these agricultural crops are intimately intermixed in a complex arrangement with a higher canopy of indigenous or planted multipurpose trees. There is also a middle canopy of fruit and multipurpose trees/shrubs; followed by a lower ground cover of food crops, medicinal plants and annual fodder plants (O'Kting'ati and Kessy, 1991). Apparently, the vertical stratification of home garden as noted here provides a gradient in light and relative humidity, which creates different niches for enabling various species groups to exploit them.

2.3 Institutions

North (1990) defines institutions as formal rules, informal constraints (norms of behaviour, conventions, and self-imposed codes of conduct), imposed by the rules of the game in society. They include any form of constraint that human beings devise to shape human interaction. They comprise policies, laws, rules regulations, and core values of an organization, operational plans and procedures, incentive mechanisms, accountability mechanisms, norms, traditions, practices, and customs (Mbeyale *et al.*, 2009). Therefore institutions encourage order in a society by shaping human interaction in social, economic and political life (Farjoun, 2002). Institutions are diverse and dynamic. They involve constitutional code, organizational order as well as normative/ customary behavioral changes. Whereas the constitutional order characterizes the rule-making process that includes the making of the national constitution and the related governance framework, the organizational arrangements are determined by the institutional code that is characterized by by-laws, regulations, associations, contracts and conventions that are created within and by the constitutional order (North, 1990; Ostrom, 1990). The normative behavioral code, on the other hand, relates to cultural values, customs and norms that legitimize the institutional arrangements and constrains the behavior of individuals and groups in the society.

2.3.1 Formal institutions

Formal institutions refer to the rules that guide access, control, and management of resources and which are backed up and enforced by the state. These include the written laws, regulations and procedures (Kajembe and Monela, 2000). They constitute the written or codified rules such as the constitution, judiciary laws, organized markets and property rights.

2.3.2 Informal institutions

Informal institutions are systems of rules and decision-making procedures which evolved from endogenous socio-cultural codes and give rise to social practices, assign roles to participants, and guide interactions among resource users (Appiah-Opoku and Mulamoottil, 1997). These are informal established procedures which include norms, myths, practices, and patterns of behaviors (Kajembe and Monela, 2000). They are the rules governed by behavioral norms in society, family or community, and include sanctions, taboos, traditions and code of conduct. Unlike the formal ones, the informal institutions are not purposively designed at one moment. They rather evolve through continuous interaction, normally in response to the prevailing situations (North, 1990), embedded in and interwoven with the existing customs, traditions, norms, beliefs, folklores and tales. Essentially, informal institutions tend to solicit more deference and recognition at the grassroots level of the society. Local institutions fit into this category. They may take the shape of a formal organizational structure, but commonly consist of informal norms and practices within a community or ethnic group. However, formal institutions also abound and are important in the local setting.

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 Selection of the Study Area

Two villages namely Tema village and Korini Juu village which are administered in Mbokomu Ward were selected as study area. Selection of the study area was based on various factors but mainly its geographical location, economic activities (intensive smallholder production i.e. homegardens) biophysical features i.e. climatic condition, as well as socio-cultural context. According to Kitalyi and Soin (2004), Chagga homegarden is multi-storeyed land use system which is highly integrated with a rich biodiversity whose stability in the past was attributed to reliable rainfall, fertile volcanic soils, good vegetation cover and a well-managed system under the Chagga informal or local institutions (rules, customs and norms). Tema village and Korini Juu village in Mbokomu Ward is an area representing parts of the slopes of the mount Kilimanjaro (coffee-banana belt and homegarden area) between 1200 and 1800 m above sea level (Misana *et al.*, 2012), with only small-scale farming and no big farm estates in between where considerable socio-cultural aspects related to local institutions disparities are common. Thus, these villages (Tema and Korini Juu) were an interesting case for this study.

3.2 Brief Description of the Study Area

3.2.1 Geographical location and demographic

The study was conducted in Tema and Korini Juu villages in Mbokomu Ward in Moshi Rural District, Kilimanjaro Region (Figure 4, Map of the study area). Moshi Rural District is between longitude 37° and 38° East and latitude 2°30' and 2°50' South. On the North it borders Rombo District, on the East it borders Kenya on the South it borders Mwanga and Simanjiro Districts and to the Western side it borders Hai District.

The District is inhabited by 466 737 people of whom 225 767 are males and 240 970 are females with average household size of 4.2, while in Mbokomu ward the population is 14 606 people, of whom 7036 are males and 7570 are females with an average household size of 4.1 (National Bureau of Statistics, 2013). Figure 3 represents the population of Moshi District between 1988 and 2012.

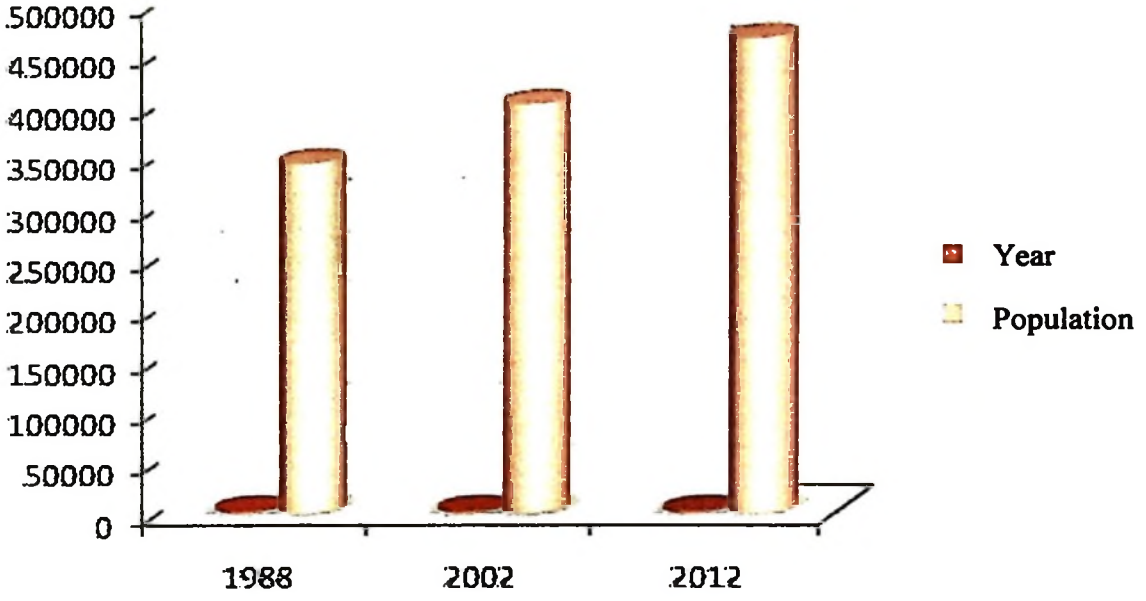


Figure 3: Moshi Rural district population

Source: National Bureau of Statistics, (2013)

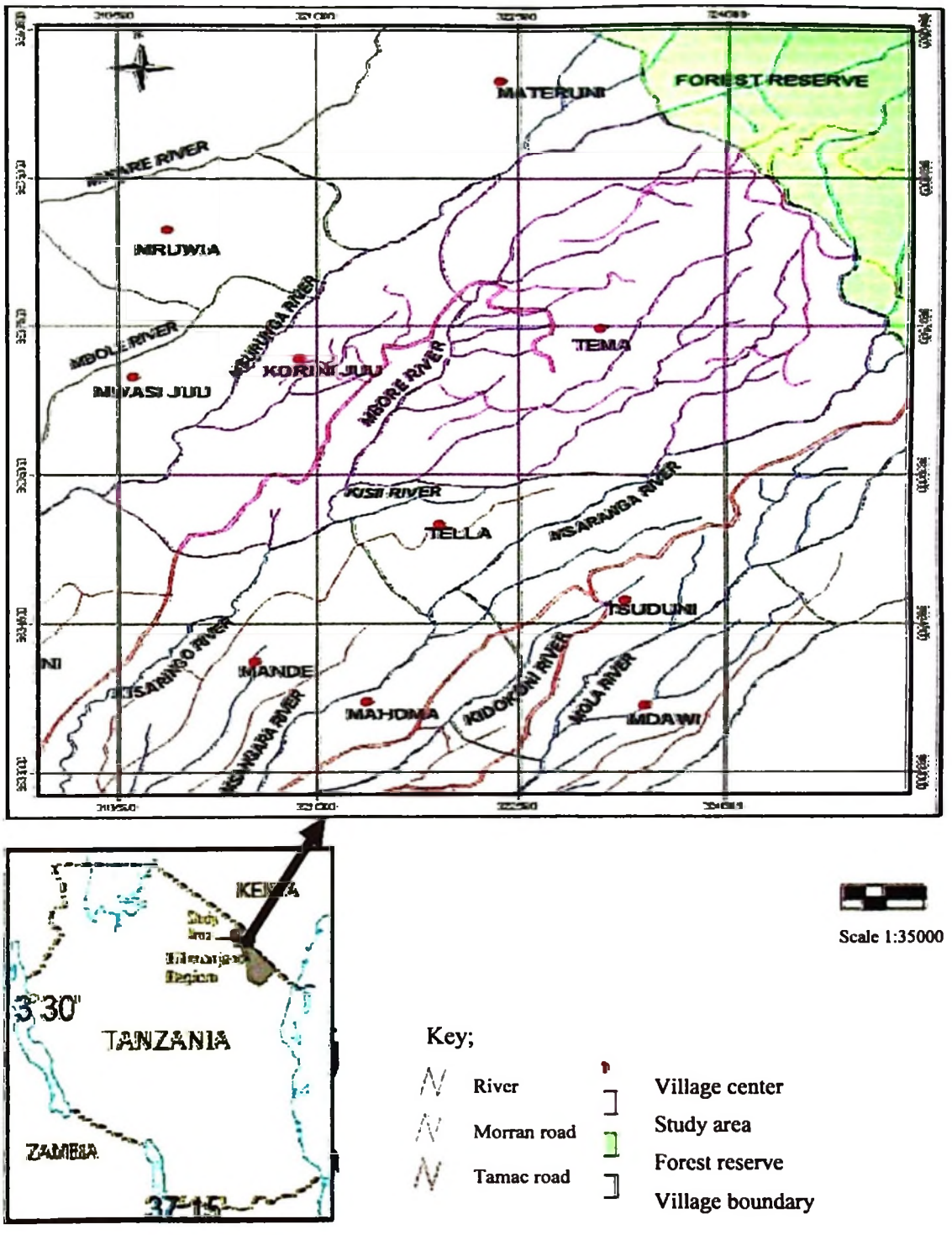


Figure 4: Map of the study area

3.2.2 Economic activities

Agriculture and livestock constitute the mainstay of the economy of Moshi District and are the main source of income, employment and household consumption (Moshi District Council, 2011). Only a small proportion of the population is engaged in the commercial and industrial sectors. The land currently under cultivation is 108 389 hectares or 87.2% of the total arable land (124 254 ha). About 68 718 households are fully engaged in agriculture. The south-eastern and eastern slopes are characterized by intensive smallholder production of both subsistence and cash crops. Individual homesteads are densely grouped and food crops are grown under the canopies of banana and coffee which constitute the Chagga homegardens. In addition, there are state-owned coffee estates and farms. The drier northern and western slopes are used mainly for extensive grazing by the Masai. The district has over 300 traditional irrigation furrows, streams and rivers that are conducive to irrigation farming. Moshi District is endowed with one of the world's wonders, Mt. Kilimanjaro (the highest mountain in Africa – 5895 metres above sea level) which offers a huge room for tourism.

3.2.3 Biophysical features

Moshi district is characterized by a mountainous topography in the northern part which forms the Kilimanjaro Mountain, and lowlands in the south. Kilimanjaro Region has a bimodal rainfall pattern with short rains from October to December and long rains from March to May. The average annual rainfall ranges from 1000 to 1700 mm with marked variation depending on elevation, exposure, and aspect. Thus, Kilimanjaro gets more rainfall on its south-eastern and eastern flanks (where the Chagga homegardens are) than on its northern and western sides, which are sheltered from the wet south-east. The lowlands receive an average of 600 mm, the central part 1100 mm and the high lands 1600 mm. Average daily temperature is 26° C. The highest temperatures occur in the

months of February, March, April, September October and November during which the mean maximum temperatures are around 31° while the mean minimum temperatures are in June, July, December and January when the temperatures go down to about 15°C.

The district has 3 agro ecological zones. The lower zone with the altitude ranging from 700 – 900 meters above sea level is suitable for paddy production by irrigation, maize and open cattle grazing. The area is sparsely populated with population ranging between 15 – 30 people per square kilometer as compared to other areas. The middle zone with altitude ranging from 901 – 1500 meters above sea level where people are engaged in agriculture. The main crops are coffee, maize, beans and fruits while dairy cattle keeping is practised on zero grazing system. The middle zone is less populated as compared to the highlands. The upper zone (highlands) is located on the slopes of Mt. Kilimanjaro with altitude ranging from 1501 – 5895 meters above sea level and most densely populated. People in this zone are engaged in agriculture main crops are coffee, banana and fruits with diary cattle being kept on zero grazing system.

Soils in the region are humic nitosols and associated humic andosols, chromic cambisols and associated eutric cambisols, orchric andosols and associated chromic cambisols and vitric andosols finaly mollic andosols and associated eutric nitosols. In general, these volcanic soils are fertile with a high base saturation and cation exchange capacity (CEC). A major limitation is the steep slopes which prevent mechanization and require substantial erosion control measures. Other limitations include stoniness or a shallow petrocalcic horizon.

3.3 Research Design

A cross-section research design was adopted during data collection whereby data were collected once at a single point in time (Creswell, 2002). The choice of this method was partly based on its ability to meet the objectives of the study and time.

The sample units for data collection were villages and households. A village in the Tanzanian context is considered as the lowest administrative unit and a focal point for any development intervention (Mbeyale *et al.*, 2009). A household on the other hand is a smallest unit within a village. Household heads who practice homegarden were the key respondents during household survey as they are the ultimate decision makers for the households (Kajembe, 1994).

3.4 Sampling Techniques

A purposive sampling technique was used to sample two villages out of three villages of Mbokomu Ward for Household Surveys with the aid of the District village map. Villages were selected on the basis of accessibility, agro-ecological zone, proximity, homogeneity, time and the spatial difference. This aimed at broadening the scope of the study in terms of type of socio-economic activities undertaken that would mean differential local institution roles and homegarden performance between the two villages.

Simple random sampling was employed to select a total of 90 households, 35 households for Korini Juu village and 45 households for Tema village from villages register books and sub village leaders assisted in identifying them. Simple random sampling aimed to minimize sampling bias as every individual household had an equal chance of being selected.

3.5 Data collection

Various participatory research techniques were employed which combine Geographic Information System (GIS) technologies, existing data sets and historical records to collect quantitative, qualitative and spatial data through primary and secondary data sources.

3.5.1 Secondary data collection

Secondary data were mainly obtained through reviews of literature or documentation from secondary sources e.g. published and unpublished materials such as books, journals, dissertations and papers. Information collected through literature review included climatic data (rainfall and temperature data) from the office of the DALDO, historical trend, traditional, culture, demographic data, policy related information and biophysical information. Information obtained through this method was used to complement those that were collected through primary data sources.

3.5.2 Primary data collection

3.5.2.1 Household survey

Surveys were conducted between early January and March, 2013. Semi-structured questionnaires were administered to 90 sampled households in the two study villages (Appendix 1). Respondents were assured that there would be great confidentiality and that no names would be disclosed that ensured respondents freedom in responding to questions. Information collected with this method related to local perceptions on institutional roles, homegarden performance, and socio-economic implications. Most interviews were conducted at the respondents' homes while a few were conducted while the respondents are still working in the homegarden. It was deemed important to administer the questionnaire in the fields such that observations could be made concurrently to minimize time and allow probing.

3.5.2.2 Focus group discussion

Three Focus Groups in each village where formed with participants experienced in farming, livestock keeping and knowledge of the local climate to capture more information from each group. Information collected using Focus Group Discussion included perceptions on local institutional, homegarden performance, indigenous knowledge, norms, and traditions. The essence of this method was to collect in-depth information related to the 'why' and 'how' side of information collected using household surveys. This method broadened understanding of the scope of the study. Thus, a checklist was prepared and used during discussion (Appendix 2). Discussions were conducted in a relaxed atmosphere to enable participants to express themselves without any personal inhibitions, and participants were also asked to observe the rule of respecting each other.

3.5.2.3 Key informant interview

Key informants were necessary to obtain information from an informed audience with experience and knowledge in homegarden, farming, traditional, culture, norms, livestock keeping and the local environment. A total of 15 key informants comprised 5 District Council workers, community development officers, extension officer and environmental officers were selected and interviewed and the rest were farmers included owners of farms who long-time residents in the area. Among others, local leaders were also selected because they were more informed on community affairs, were relatively better trained, and use local institutions in their leadership. The roles, strengths and weaknesses of local institutions were discussed with key informants.The key informant interviews were carried out in an informal way, which enhance probing and gaining information related to who does what and why using checklist prepared to guide the interviews (Appendix 2).

3.5.2.4 Direct observation

The sites for the field surveys were selected based on the activities that were being carried out and a total of two sites in each village were visited. Farming together with livestock keeping sites, water sources, sacred areas and fuel wood collection were activities based on selecting a site to visit for the purpose of gaining insight on the nature of areas where such activities were being carried out. In some cases observations were carried out concurrently with administering of household questionnaires and checklist. The aim was to correlate information collected by social methods with field conditions.

3.5.3 Spatial data collection

Landsat TM satellite imageries (Path 167 Row 63) of 1987, 1995 and 2013 covering the study area were downloaded from the U.S. Geological Survey (USGS) website (http://glovis.usgs.gov) and used as the base for describing land use status. 7-zip software was used to unzip the downloaded zipped file with different image bands together with a ReadMe.txt file which opened using a WordPad to obtain more information about data and especially which dataset represents which band. The ERDAS Imagine 2011 and ArgGIS 10.0 software were used for all satellite image data visualization and manipulation. Arc catalog were used to visualize the unzipped dataset and Erdas imagine 2011 was used to stack together all seven bands in unzipped dataset in order to have a single image with band combination "1234567" for easy interpretation and manipulation. Then satellite imageries were pre-processed to assist collection of ground truthing information.

3.5.3.1 Image pre-processing

A geometric correction procedure was used to register each pixel to real world coordinates. In this process images were rectified to a Universal Transverse Mercator

(UTM) coordinate system using Erdas imagine analysis software in ArcGIS 10.0 software. The reference system used to geo-reference the image was UTM coordinate system, Zone 37. The imageries were projected to the common coordinate system and resampled to the same spatial resolution. Prior to field visit, a preliminary land cover map of the study area was produced from image of 2013 to assist ground truthing assessment.

3.5.3.2 Ground truthing

Ground truthing exercise was carried out in November, 2013 with the help of Google earth and GPS. The enhanced colour composite image printouts and topographic maps of the area were used to develop ground signatures. In the study site, the recognizable features on the ground were identified and related to features observed on the color composite print outs. The identification of ground features was done by locating easily-observable features such as roads and river networks and thereafter related to vegetation types and land uses. The features were recorded as points using GPS. The local community members provided the onsite local knowledge including types of land cover and land uses, as well as land cover changes. As the interpretation of all the three sets of images was done by the same interpreter, the reliability of interpretation is approximately the same for the three older image sets.

3.6 Data Analysis

Objective I was addressed using historical trend analysis to understand how local institutions were working and how their importance has changed overtime.

Objective II was addressed using a broad combination of Participatory Learning and Action (PLA) and Geographic Information Systems (GIS) through historical and archival records, key informant interviews and household surveys to identify land use existence and their change. Historical records are well known to provide detailed accounts of

resource management strategies, and how they influenced local land use and resource management strategies (Rao and Pant, 2001). The combination of remote sensing data, household survey and participatory research methods have been used worldwide to understand local land use change (Cousins, 1999; Leach and Fairhead, 2000; Mertens *et al.*, 2000).

Objective III was achieved partly using descriptive statistics such as means and percentages while the remaining part was analyzed using multiple regression analysis. On the other hand R^2 values were used to measure the overall explanation power of the regression model, while t-test was used to provide the degree of significance of the parameter estimates of the model at 5% probability level.

3.6.1 Qualitative data analysis

Qualitative data was subjected into content analysis and stakeholder analysis. Content analysis is a set of methods for analyzing the symbolic content of any communication. The basic idea as suggested by Singleton *et al.* (1993) is to reduce the total content of communication to some set of categories that represent some characteristics of research interest. According to Kajembe and Monela (2000), this technique helps the researcher in ascertaining values and attitudes of the respondents thereby generating themes and tendencies.

Qualitative information from observation, verbal discussions, reports and other documents were first sorted and summarized, then analysed using an Excel worksheet, and interpreted. This information was used to support or otherwise the quantitative information

3.6.2 Quantitative data analysis

Data from questionnaires was summarized and coded. The coding involves structuring the responses from open and closed ended questions and assigning them nominal value for analytical purposes. Both descriptive statistic (frequencies, percentages, mean, standard deviation, and cross tabulation) and inferential statistical analyses were applied using computer data processing software i.e. Statistical Package for Social Sciences (SPSS) version 16.0. Findings from the analysis were then presented in the form of tables.

In evaluating homegarden performance, Ordinary least squares method of regression was used to analyze the effects of social economic factors on the volume of milk marketed by different respondents. The selection was due to the fact that 100% of sample respondents keep dairy cow and also keep records of milk produced and supplied, therefore it was noted that milk production was one of the most important source of income for every household and that it can influence other factors and in this case used as a proxy of the production performance of Chagga homegarden. Regression analysis is a statistical tool for evaluating the relationship between one or more independent variables to a single continuous dependent variable Y (production performance of Chagga homegarden). The multiple linear regression model for this study was specified as follows:

Y_i = f(Age of respondents, Family size, Distance to market, Education level, Availability of input, Small business, Loan obtained, Extension visit, Number of milked cows)

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu_i \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where Yi = volume of milk supplied to the market

β = a vector of estimated coefficient of the explanatory variables

X= a vector of explanatory variables

μ_i= disturbance (error) term

When some of the assumptions of the Classical Linear Regression (CLR) model are violated, the parameter estimates of the above model may not be Best Linear Unbiased Estimator (BLUE). Moreover, high multicollinearity may render important variables insignificant. Thus, it was important to check the presence of multicollinearity among the variables that affect supply of milk in the area.

To detect multicollinearity problem for continuous variables, Variance inflation factor (VIF) for each coefficient in a regression as a diagnostic statistic was used. As a rule of thumb, Gujarati (2003) stated that if the VIF value of a variable exceeds 10, which will happen if R^2 exceeds 0.90, then, that variable is said to be highly collinear. Therefore, for this study, VIF was used to detect multicollinearity problem for continuous variables.

3.6.3.1 Definition of variables

a. Dependent variable

Volume of milk marketed is a continuous variable representing the dependent variable. It was the amount of milk supplied by households to the collection centre and measured in litters. Milk production is taken to be a proxy for homegarden production performance since a farmer with cattle will have different shrub species together with banana plants for forage hence sustain the homegarden. The main assumption is every household in the Chagga homegarden system keeps at least one dairy herd of cattle.

b. The Independent variables :

X_1= Distance to market

Distance to market (milk collection centre) measured in kilometers is a proxy of integration to market. Market is very essential in agroforestry management as most of the homegarden products (e.g. milk) are perishable. As a result, access to market is

paramount to avoid spoilage of products. Distance to market is expected to have a negative (-) effect on milk production.

X_2= Small business

Small business is a categorical variable with 1=most important source of income, 2= important and 3=not important source of income. This implies that having a small business as non-farm activities would decrease the probability of that family to participate in homegarden management hence decrease the quantity of milk produced hence expected to have negative (-) effect on milk production.

X_3= Age of respondents

Age of respondent in years is a continuous variable and is proxy measure of farming experience of household. Aged households are believed to be wise in resource use. An aged person has the ability of securing land and has the wisdom of conserving it, and hence will have positive effect on homegarden performance therefore age is expected to have a positive (+) effect on milk production. On the other hand older households may also be tradition bound and reluctant to take up new technologies, hence negatively (-) affecting milk production. The age of a person is usually a factor that can explain the level of production and efficiency.

X_4= Education level of the household head

It is a continuous variable and refers to the formal schooling of a respondent during the survey period. Formal education determines the readiness of household heads to accept new ideas and innovations, and make it easy to get supply, demand and price information and this enhances farmers' willingness to produce more and increase volume of sales. It is assumed that education is one of the strongest determinants of household income.

A farmer with more formal education plans his farming more properly and in so doing is able to obtain better yields. This could be justified from the point of view that a farmer with more formal education and a proper job could have more capital to invest in his farming and therefore, education level was assumed to contribute to performance of homegardens. In this case a positive (+) affect was assumed. Meanwhile an educated farmer with a proper job could have insufficient time to participate in homegarden management hence contribute less to the performance of homegarden. A negative (-) affect was assumed in this case.

X_5= Family size

A household refers to a group of people who eat and dwell together under same household head. The household size was assumed to be an important factor in determining the extent to which labour would be available in production and management activities of homegarden hence quantity of milk produced. Lack of labour force was often mentioned as a hindrance to effective farming while family labour was considered as the main source of labour in the study area. The expected sign of the regression coefficient was positive (+).

X_6= Access to credit (financial support services)

Access to credit is measured as a dummy variable taking a value of one if the household has access to credit and zero otherwise. Among other things, credit access is assumed to have a significant positive effect to the volume of milk marketed because a farmer who has access to credit facility can purchase inputs and hence increase the production and marketable volume of milk.

X_7= Access to extension service on milk production

This variable is measured as a dummy variable taking a value of one if the respondent has access to homegarden production extension service and zero otherwise. It is expected that extension service widens the household's knowledge with regard to the use of improved animal husbandry techniques and has positive (+) impact on volume of milk produced. Farmers who have frequent contact with extension agents will have better access to information and could adopt better technology that would increase the volume of milk marketed. Extension agents serve as a catalyst of local innovation and as information "broker" who can bring together local and externally derived knowledge in improving agricultural technology by encouraging farmers to try alternative designs in increasing productivity.

X_8= Number of milked cows

Having dairy cattle was assumed to add incentive to the cropping system by allowing the farmer to invest on his farm. Also milk production acts as another option for family income which results in improved homegarden performance. Therefore household having a large number of milked cows was expected to increase the quantity of milk marketed (positive effect) and at the same time increase homegarden performance.

3.6.3 Spatial data analysis

3.6.3.1 Digital image classification

Digital image classification was done by combining both unsupervised and supervised classification. The unsupervised classification was done first followed by supervised classification by using Erdas imagine 2011 software.

Unsupervised Classification

In unsupervised image classification pixels that have similar spectral values were grouped without any prior knowledge of existing cover type. The analyst then combined and relabelled spectral classes into real different land cover types as unambiguously as possible with the aid of baseline maps, field-based knowledge and ground signatures recorded by using GPS. This resulted in seven main land cover types classified as settlement, riverine vegetation, mixed cropland, homegarden, field, bare land and forest. ERDAS Imagine 2011 software was then used to perform unsupervised classification. This method of image classification was very important as it gave an idea of which classes are confusing hence to focus more on those areas in the supervised classification.

Supervised classification

In supervised classification, areas of known cover types were sampled to determine and train their spectral values, which are used in a specified algorithm to classify the pixels in selected information classes. In this process, training pixels that are representative of the desired land use classes were selected. This was verified from other data sources including, aerial photograph, Google Earth image of 2013, SPOT Image Level 1A of 2.5 m x 2.5 m resolution of 2007 and field experience (Ground truth data). The different classes of training pixel information ware then stored as a signature file in ERDAS Imagine. The signature file and the trained satellite image were then used in running a supervised classification using ERDAS Imagine 2011 software. In this classification seven land cover classes were identified which include settlements, riverine vegetation, mixed crop land, homegarden, field, forest and bare land.

3.6.3.2 Change detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times. Essentially, it involves the ability to quantify temporal effects using multitemporal data sets (Singh, 1989). Many change detection methods have been developed such as image post-classification, image regression and principal component analysis which are used for various applications (Chen *et al.*, 1999). In this study, post-classification change detection approach was used whereby comparison of independently classified land cover maps of 1987, 1995 and 2013 was carried out. By using post-classification change detection approach, the classified imageries of 1987, 1995 and 2013 (in shape-file format) were labeled cover 1987, cover 1995 and cover 2013. The area of change was then extracted through the direct comparison of the classification results (Biging *et al.*, 1998).

The technique used for change detection was GIS overlay in ARC VIEW (intersect operation) with mathematical algorithm as presented in equations 2 and 3. This resulted in output tables. The output tables were then exported to MS EXCEL and further processed by using pivot table function to summarize the land cover changes. The main advantage of post-classification method is its ability to by-pass difficulties associated with the analysis of images acquired at different times of year or sensor (Chen *et al.*, 1999). However the main disadvantage of the approach is that, it depends on land cover change results of the individual classification accuracies.

$$\%\ \text{Cover change } 1987\text{-}1995 = \frac{Land\,cover_{1987} - Land\,cover_{1995}}{Land\,cover_{1987}} \times 100\ \% \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$\%\ \text{Cover change } 1995\text{-}2013 = \frac{Land\,cover_{1995} - Land\,cover_{2013}}{Land\,cover_{1995}} \times 100\ \% \quad \ldots\ldots\ldots\ldots\ldots (3)$$

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Local Institutions Responsible in Managing the Chagga Homegardens

Results indicate that institutions are important in managing the Chagga home gardens both formal and informal. Five main local institutions were identified with some having more than one function in managing Chagga homegarden. These are leadership institution, conflict resolution institution, land and livestock-based institution, health and beliefs institution and recreational institution. Table 1 gives the summary of major local institutions found in the Chagga homegarden within the study area.

Table 1: Summary of main local institutions in the Chagga homegarden

S/N	Type of institutions	Informal	Formal
1	Leadership	Traditional leaders	Local government authorities
2	Conflict resolution	*Mangi* and Council of elders	Village land council
3	Land and Livestock-based	Inheritance ownership Half-sharing of livestock (*kopa ng'ombe/mbuzi lipa ng'ombe/mbuzi*)	Village land committee, Village agriculture extension officer (VAEO) and Village livestock extension officer (VLEO)
4	Health and Beliefs	Traditional beliefs	Village health committee, Churches
5	Recreational	Traditional dances *(Mtingo)*	Sports

4.1.1 Leadership institution

4.1.1.1 Informal leadership

Informal leadership as reflected in Figure 5 consists of traditional leaders. *Mangi* (Chief) who has high status in the traditional belief system and serves as the ultimate authority of the Chagga, he has a territory equivalent to a size of current division. He was supported by sub-chief (*Mlao*) who subordinate to the chief and performing most functions in the absence of *Mangi*. Under him there was *Mchili* who organizing his subjects within a territory size equivalent to a village.

Traditional leaders had powerful influence on their subjects by functioning as diviners, rainmakers and judges. They were also considered as spiritual leaders, integrating spirituality with homegarden resource governance. Through the legitimate powers bestowed on them by the community, social harmony and the spirit of unity were ensured and this could be exploited to include aspects of homegarden management in their activities. Informal leadership in the study area do no longer exist since when all the chiefdoms were abolished after independence.

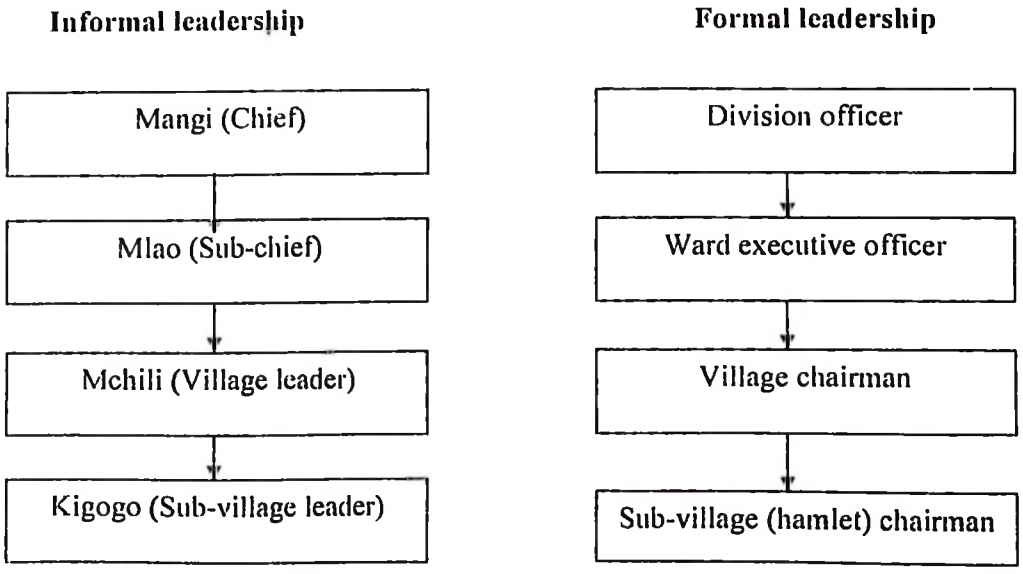


Figure 5: Informal and formal leadership institutions at Chagga homegarden

4.1.1.2 Formal leadership

Local government authority is the formal leadership institution existing in the study area (Figure 5). With reference to the informal leadership the formal leader at the division level is the division officer who is entitled to ensure peace and harmony within the division and Ward Executive Officer (WEO) who is the chief executive officer for a ward. WEO works with Ward Development Committee which consists; the councilor representing the ward, chairmen of all village councils within the ward and a member of the district council. The Village Assembly is the supreme authority on all matters in relation to the affairs of the village. It is responsible for the election of the village council. Ward Development Committee (WDC) is responsible for ensuring the implementation of the decisions and policies of the district council. The Village Council is responsible for making by-laws and ensuring the implementation of the decisions approved by village assembly. It is also responsible for ensuring the implementation of the decisions and policies of the district council brought by WDC. Sub-village (hamlet) consists a number of households headed by sub-village chairman who ensuring the implementation of the decisions from village council. In the study area, district by-laws on environmental, soil and water conservation to be implemented, the WDC of the study area comes with the police of the use of water terraces in agriculture practices. Every person on his/her homegarden has to ensure the use of terraces for soil and water conservation. Farmers are not allowed to cut trees near by water sources

4.1.2 Conflict resolution institutions

4.1.2.1 Informal conflict resolution arenas

Conflicts over management and use of homegarden resources were generally resolved by *Mangi* (Chief) through his subordinate and the council of elders. The council of elders was used by *Mangi* for advice on important issues such as land conflicts and conflicts

with neighboring villages. At clan level there was a clan head, perform roles of leadership for clan includes conflict resolution and resource allocation e.g. water distribution for homegarden. A clan head was an overseer of clan ritual places and performs all ritual.

4.1.2.2 Formal conflict resolution

In the study area the formal conflict resolution system over management and use of homegarden resources are resolved by hamlet chairman on which the failure to reach reconciliation push the matter to the higher levels which are the village land council, ward land council and primary court.

4.1.3 Land and livestock-based institutions

In pre-colonial times land was regarded as a Chief (*Mangi*) property and who wants to use it should be permitted by him (Moore, 1996). A village member who wants to use land should prepare a gift of goat (*Ndafu*) with tradition drink (*Mbege*) for *Mangi* through *Mchili*. On getting permission to that land *Mchili* with some elders was responsible to put boundaries around the land using a respected leaves *Isale* which is a highly respected landmarker. From there a land is the property of that member and is free to spit among his married sons. *Mchili* was responsible to make sure a given land was developed. Discussion with elders point out some people whose land was taken by *mchili* and given to others contrary to the present situation were no body is responsible for supervision than the owner. During interview it has been found that land was accessed through inheriting, renting and borrowing/contacting as it is shown in Table 2.

Table 2: Land acquisition in the study area

Method of obtain land	Frequency	Percentage
Inheritance	67	89.3
Renting	3	4.0
Borrowing/Contracting	5	6.7

Under inheriting, a son is traditional given land by his father ones he got married. A father was responsible for his sons' beginning of his homegarden by identifying his boundaries using respected leaf *Isale* and providing him with some banana, coffee, shading trees and a goat/cow for him to get manure. As the indication of better performance of homegarden a son is responsible for thank giving to his father by preparing a traditional party known as *Kiruhuo mawoko* with drinks prepared from son's farm. This is believed that when farther is happy for the son's success will enable the continuation of his homegarden performance. At the same time a son has to work hard for the success of his homegarden so as to give a return to his father. Nowadays land is no longer enough for split among sons while the spirit of responsibility among parents are no longer existing at the end a son can poorly manage his homegarden and yet no punishment.

Few households are involved in annual land renting arrangements. Whereby when long contract will be practiced, the renter will be motivated to make long-term investments in homegarden management such as soil conservation and tree planting rather than short-term contract (annual) which discourage farmers from taking long-term land improvements, thus greatly contributing to land degradation. A big difference was observed where by the rented homegarden are not performing better compared to the inherited one. The reason for the above could be that individual land tenure gives the individual complete rights to use land in whatever way he/she likes. Farmers do not have

interest in planting trees on land that belongs to another person. This is because tree-planting is a long-term investment and before the trees mature, the owner might have taken over. Borrowing/Contracting involves a person transferring land use rights to another person through either cash payments covering a certain period or by providing farm production to the owner e.g. a bag of maize harvested from the borrowed plot. This type of arrangement is commonly practiced by those who do own land while they are far away like staying in towns. In order not to lose the ownership they either hire a person to work for the land or give it to some relative to do so. A homegarden fall under this institution arrangement fail to get daily management practice and long term investment hence suffer land degradation.

Agricultural innovations i.e. newly introduced crops (like maize, cassava, sweet potatoes and coffee), inputs and technology led to intensification and expansion of cultivation in the study area. Changing existing indigenous tree species to more valuable or fast growing trees e.g. *Grevillea robusta* , *Eucalyptus spp* and *Albizia ssp* is typical in the study area. Table 3 show the important tree species found in homegardens.

Table 3: Important tree species in homegardens

Important tree species	Frequency	
	Most important	Important
Grevillea robusta	72.6	27.4
Albizia spp.	34.2	65.8
Persea Americana	63.0	37.0
Mangifera indica	36.0	64.0
Margaritaria discoidea	48.7	51.3
Olea welwitchii	22.0	78.0
Rauvolfia caffra	45.0	55.0
Cordia holstii	39.0	61.0
Carica papaya	41.8	58.2

Note: Multiple responses were recorded

Extension services serve as a catalyst of local innovation and as information "broker" who can bring together local and externally derived knowledge in improving agricultural technology. Farmers in the study area claim that farm extension services were more available and inputs cheaper during the period of socialism in Tanzania (1967-1983). Table 4 indicates that only 20% of the respondents have been visited by the extension agents and these agents were more inclined to disseminating information on arable crops under agriculture than on agroforestry.

Table 4: Frequency of visit by extension agent since last three farming years

Contact/visit by the extension agent	Frequency	Percentage
Yes	15	20.0
No	60	80.0

For livestock-based, farmers have improved cattle especially dairy breeds (*Fresian, Jersey, Ayrshire* and crosses involving these and local breeds) a phenomenon which has become a common trend in the area. Due to land scarcity farmers keep their livestock indoors without ever getting to move freely and get exercise while often animals are kept in small shelters built of poles with an iron sheet roof on top. As farms are small and fodder scarce farmers usually have one or two goats, some have pigs and few cows which are kept for milk and manure. There is half-sharing of livestock ownership between two individuals or households (e.g. *Kopa mbuzi lipa mbuzi*). The aim was to pool limited resources and own the animals together. The offspring remain the property of the livestock owner while the one managing the animal benefits from milk and manure. Together with those benefit, a first calf belong to the owner while the second belong to the one managing the animal. Today this is partly done among some household within a clan. This type of institution represents an important social capital with respect to

homegarden management. It enables farmers with no livestock to access manure, which is an important ingredient in soil fertility improvement in the homegarden where soil nutrient levels are depreciated.

4.1.4 Health and beliefs institutions

Health institutions for promoting traditional medicine, purification from evil spirits and invoking supernatural powers of traditional spiritual leaders were exist in the study area (Clack, 2009). Discussion with key informant reveled traditional medicine are still used by individuals and some tree species provide herbal medicine for treatment of various human and livestock diseases are exist. The medicine was extracted without destroying the trees hence conserve tree and land together. Some of medicinal plants include *Itolo* which is used for stomach ache, to get an upset stomachs or diarrhoea; they bite its leaf or drink powder of the dried leaves. In the past people in the study villages used to plant it just around the outer circumference of the traditional house, in order to prevent soil erosion under the basement of buildings in the case of heavy rain, with or without known they preserve soil erosion. *Rumex abyssinicus* (*Ilimilimi*) is used for stomach disorders; *Mnemvu* and *Tabenaemontana pachysiphon* (*Irahacha*) are act as anti-thrombin hence effective for cut wound for both animal and human. They mush leaf into paste and apply to the affected part. *Todallia asiatica* (*Mkananga*) which is used for stomach ache and cancer prevention. *Solanum incanum* (*Ndulele*) and *Vernonia adoensis* persistent cough. *Cassia didymobotrya* (*Latangao*) is an ethno-veterinary for treating constipation.

Interview with elders reveled cleansing from evil spirits (*Tambiko*) was done under sacred tree found in home garden known as *Mchihiyo/Loliondo* where the bone of dead person was used to be buried under this tree. This tree is considered as a sacred tree with important religious value including traditional rituals and worship which revered by

Chagga people as the tree dwelled by God. The selection of homegarden with sacred tree *Mchihiyo/Loliondo* to perform traditional rituals *(Tambiko)* was done by clan leaders who were believed to be the media through which their god (*Ruwa*) made contact with his people. This place which known as *Mbuonyi* is considered as clan origin since the bone of ancestors and bone of dead person of the clan was used to be buried under this tree. Areas and trees considered sacred are predominant in the agricultural landscape as giant trees, and unauthorized people are not allowed to approach or cut such trees. Many people were fear going near such places which hinder cutting of those trees hence result to land conservation. In Tema village *Albizia schimperiana/Gummifera/Lebbeck* (*Muruka*) was the tree adored by Materu clan.

Formal health and beliefs institution in the study area is religions which predominated by the christianity. Protestants had established missions in the study area together with schools and dispensary which change people from traditional beliefs to new christian beliefs. Apart from spiritual work the church help beginning of SACCOS, where members contribute a specific amount and been able to borrow some money with low interest which help in managing homegarden. In Korini Juu village a church help the start up of Mbokomu dairy company which ensures farmers milk market.

4.1.5 Recreational institutions

In the study area several recreational groups were identified, including traditional dance and sports groups, mainly football. *Mtingo* is a special traditional dance group for women and men and was used to enlighten youth on what they should expect, should do and should not do in marriage. Today this traditional dance is commonly hired to create awareness and support political campaigns instead of transferee traditional knowledge among generation. Share local drinking (*Mbege*) is a prominent recreation institution in

the study area where at the past it was more common during harvest unlike today people especial youth are wasting much of the production time on drinking.

4.2 Land use status characterizing Chagga homegarden

4.2.1 Land cover change between 1987 -2013

The major land cover classes for 1987, 1995 and 2013 are quantitatively analyzed for the area covered by each land cover categories. For a clear and informative comparison of the land cover change, area value for the two periods 1987- 1995 and 1995- 2013 for the three thematic maps as shown by Figure 6, 7 and 8 are summarized in Table 5.

Table 5: Mbokomu land cover changes from 1987 to 2013

	Proportional area coverage in (ha)						Cover change			
							1987-1995		1995-2013	
Land cover classes	Year 1987	%	Year 1995	%	Year 2013	%	(ha)	%	(ha)	%
Settlement	6,697.47	8.89	8,287.09	11	11,541.65	15.32	1597.15	2.12	3247.03	4.31
Riverine vegetation	5,145.53	6.83	6,780.35	9	4,580.50	6.08	203.41	0.27	4105.88	5.45
Mixed cropland	13,990.11	18.57	10,517.07	13.96	16,333.10	21.68	-3480.6	-4.62	5823.56	7.73
Homegarden	15,911.21	21.12	19,150.71	25.42	11,571.79	15.36	2192.31	2.91	-6531.7	-8.67
Agriculture field	8,942.52	11.87	8,309.69	11.03	5,642.75	10.53	-632.83	-0.84	-2666.9	-3.54
Forest	13,063.47	17.34	12,724.45	16.89	14,916.76	16.76	-2139.6	-2.84	-5160.6	-6.85
Bare land	11,586.68	15.38	9,567.82	12.7	10,750.61	14.27	-2019	-2.68	1182.79	1.57
Total	75,337.17	100	75,337.17	100	75,337.17	100				

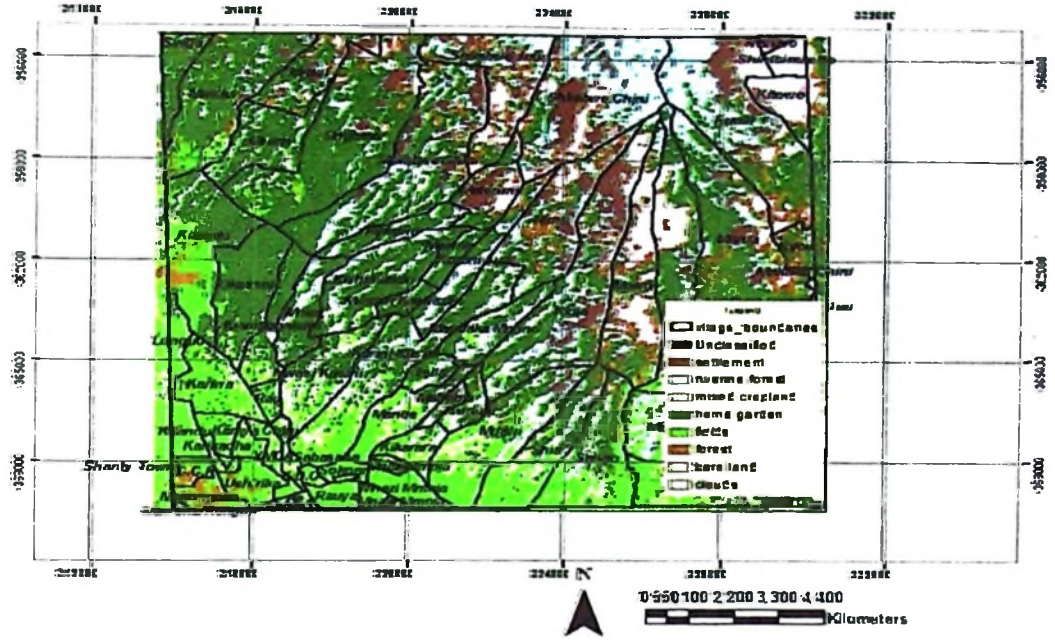


Figure 6: Mbokomu land cover map for the year 1987

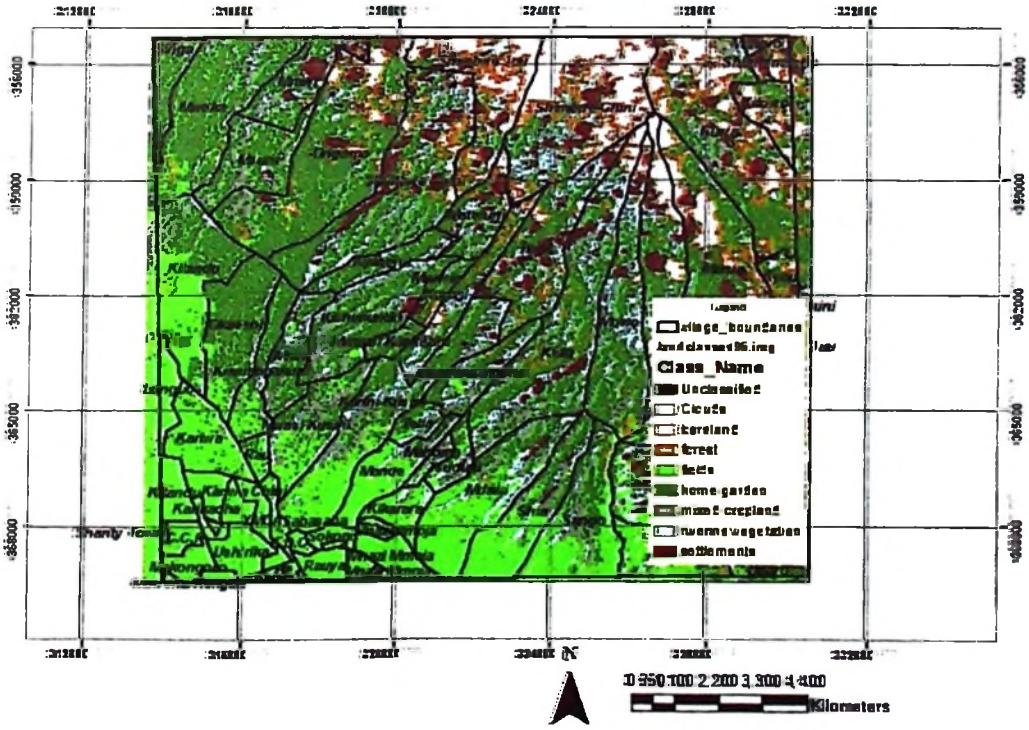


Figure 7: Mbokomu land cover map for the year 1995

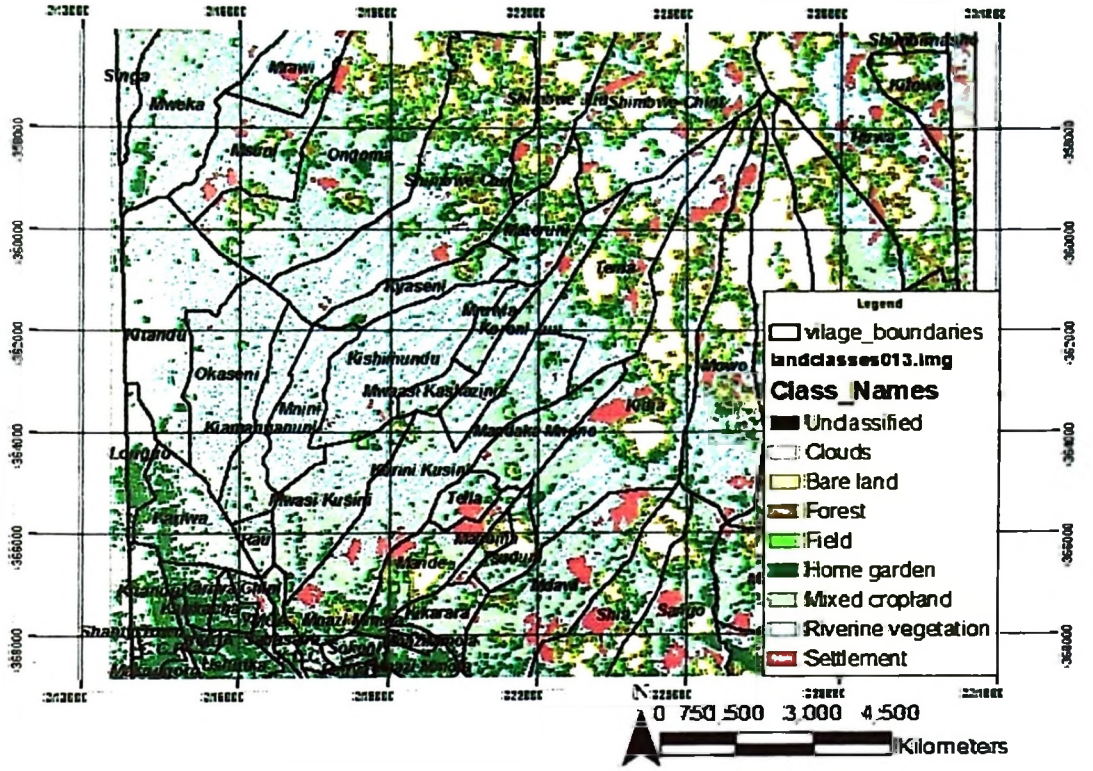


Figure 8: Mbokomu land cover map for the year 2013

Based on Table 5, in the first period (1987 - 1995) settlement, riverine vegetation and homegarden increases by 2.11%, 2.1% and 4.30% respectively, while mixed crops, agriculture field, forest and bare land decreased by 4.61%, 0.84%, 2, 84%, 0.45% and 2.68% respectively. During the second period (1995 - 2013) settlement continued to be increased by 4.32% while forest cover and agriculture field continued to be decreased by 0.13% and 0.5%. Moreover mixed crops and bare land which was decreased in the first period, in the second period it increased by 7.72% and 1.57% while homegarden and riverine which was increased in the first period, in the second period it decreased by 10.06%and 2.32% respectively. This indicates that there was transformation of these land cover types to the others.

4.2.2 Post-classification change detection matrix

To assess the change from one date to the other, each raster cell from 1987 was compared with the corresponding cell in the 1995 and the raster cell from 1995 with the corresponding cell in 2013. This procedure creates a table showing the initial value of each cell of 1987 and the final value of each cell of 1995 for the first period. Similarly for the second period the initial value is the 1995 cell value and final value is the 2013 cell value (Table 6 and 7).

A change matrix with initial year data in the rows and the final year data in the columns was created for the two periods (1987 -1995) and (1995 -2013). In the matrix table the class total value of the column indicates the initial stage image total percentage area of each land cover classes and the row total represents the final stage percentage area of land cover classes. Whereas the class change tells the total percentage areas of each land cover classes that were transformed to other land cover type. The image difference is the total net change of the two time images. The negative image difference indicates a certain land cover is in a state of decrement and the positive value indicates increment.

4.2.2.1 Change detection between 1987 and 1995

In Table 6, the image difference indicated mixed cropland, agriculture field, forest and bare land decreased by 32.27%, 5.88%, 44.17% and 18.76% respectively. Settlement, riverine vegetation and homegarden land showed an increase of 14.77%, 30.1% and 15.19% respectively.

Table 6: Change detection matrix of land cover types in Mbokomu between 1987 and 1995 (% ha)

		1987 (Initial year)							
	Land cover type	Settlement	Riverine vegetation	Mixed cropland	Homegarden	Agriculture Field	Forest	Bare land	Row total
1995 (Final year)	Settlement	19.89	17.83	29.57	32.12	22.87	28.34	26.38	177
	Riverine vegetation	17.89	15.83	27.57	30.12	20.87	26.34	24.38	163
	Mixed cropland	22.85	20.79	32.53	35.08	25.83	31.3	29.34	197.72
	Homegarden	34.31	32.25	43.99	46.54	37.29	42.76	40.8	277.94
	Agriculture field	19.92	17.86	29.6	32.15	22.9	28.37	26.41	177.21
	Forest	25.78	23.72	35.46	38.01	28.76	34.23	32.27	218.23
	Bare land	21.59	19.53	31.27	33.82	24.57	30.04	28.08	188.9
	Class total	**162.23**	**147.81**	**229.99**	**247.84**	**183.09**	**221.38**	**207.66**	
	Class change	**142.34**	**131.98**	**197.46**	**201.3**	**160.19**	**187.15**	**179.58**	
	Image difference	**14.77**	**15.19**	**-32.27**	**30.1**	**-5.88**	**-44.17**	**-18.76**	

Although 46.54% of the area covered by homegarden in 1987 has not changed, about 32.12% of the total transformation of homegarden cover had occurred to settlement cover due to population increase. Figure 9 indicates the population increase of Moshi rural district from 316 920 people in 1978, 342 553 people in 1988 to 391 281 people in 1995.

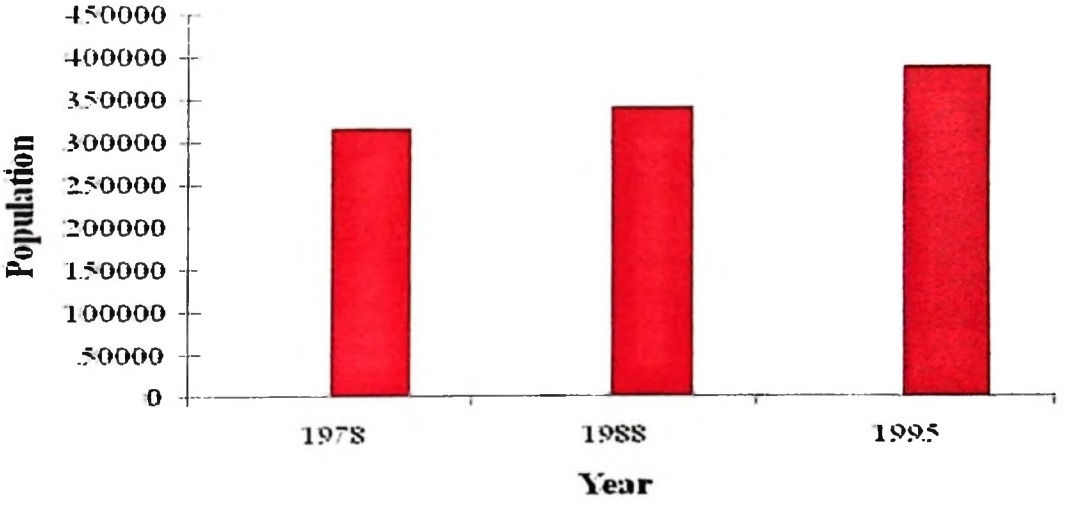


Figure 9: Population trend of Moshi rural district

Source: (NBS, 2013).

The other changing of homegarden to other land use type was into riverine vegetation 30.12%, mixed cropland 35.08%, agriculture field 32.15%, forest cover 38.01% and bare land 33.82%. It has been revealed that institutional changes are among the factors influencing those land use changes. The establishment of cooperatives during the colonial period, abolition of chiefdoms in 1962, abolition of local government authorities (LGAs) in 1972 and their re-establishment in 1982, as well as the abolition of cooperatives in 1976 and their re-establishment in 1984 are among institutional factors mainly related to the above land cover changes.

the local economy and management of resources. During the colonial period, the traditional rulers (chiefs) were the custodians of natural resources (Clack, 2009). The abolishment of chiefdoms in 1962 changed completely the structure of the local government and land tenure as the traditional rulers no longer had powers or control over the management of the resources. This opened doors for abuse of the resources particularly in the half-mile forest strip on which people in the study area depend. Its management focus changed from a social to a commercial forest with more trees being cut than planted (as indicated by decreases in forest cover by 44.17% from 1987 to 1995).

On the other hand the information from former village leaders' show that re-establishment of Local Government Authorities (LGAs) in 1982 through their stated by-laws facilitated the management of homegarden especially on tree cutting practices and water sources protection. At village level the study prevailing land-based institution was used, where by people used to put up terraces on the steep slopes known as '*Makinga maji*' and this practice was embedded in their farming operations. Farmers used to have songs and slogan encouraging each other to make terraces hence conserve soil and sources of water. No one was allowed to cut a tree without replacing it by planting another trees. A tree like *Ficus* spp was grown close or along the water sources and in catchment areas. Ever though it was estimated that a Chagga homegarden supplies 1/4 to 1/3 of the fuelwood requirements of a family (Fernandes *et al.*, 1984), a tree like *Grevillea robusta*, was a one of the classical example of an exotic tree introduced for productions of timber and poles in Chagga homegardens and harvesting were done traditionally through selective wood harvesting that do not involves complete removal of tree cover (O'Kting'ati and Kessy, 1991) which on turn resulted into an increase in homegarden cover and riverine vegetation cover as reflected in Table 6 above.

4.2.2.2 Change detection between 1995 and 2013

The changes detected in this period indicated that homegarden cover decreases by 70.42% in 1995-2013 as shown in Table 7. The decline in homegarden cover indicates the presence of human disturbances which is the result of an increase in population in Moshi rural from 391281 people in 1995 to 402 431 people in 2000 and then to 466 737 people in 2012 (NBS, 2013). The increase in population results to an increase in settlement cover by 30.24% between 1995 -2013.

Table 7: Change detection matrix of land cover types in Mbokomu between 1995 and 2013 (ha)

		1995 (Initial year)							
	Land cover type	**Settlement**	**Riverine vegetation**	**Mixed cropland**	**Homegarden**	**Agriculture field**	**Forest**	**Bare land**	**Row total**
	Settlement	**26.32**	24.32	29.28	40.74	26.35	32.21	28.02	207.24
	Riverine vegetation	17.08	**15.08**	20.04	31.5	17.11	22.97	18.78	142.56
	Mixed cropland	32.68	30.68	**35.64**	47.1	32.71	38.57	34.38	251.76
2013 (Final year)	Homegarden	26.36	24.36	29.32	**40.78**	26.39	32.25	28.06	207.52
	Agriculture field	21.53	19.53	24.49	35.95	**21.56**	27.42	23.23	173.71
	Forest	27.76	25.76	30.72	42.18	27.79	**33.65**	29.46	217.32
	Bare land	25.27	23.27	28.23	39.69	25.3	31.16	**26.97**	199.89
	Class total	177	163	197.72	277.94	177.21	218.23	188.9	
	Class change	150.68	147.92	162.08	237.16	155.65	184.58	161.93	
	Image difference	**30.24**	**-20.44**	**54.04**	**-70.42**	**-3.5**	**-0.91**	**10.99**	

It was learnt during the visit that due to the decreased productivity and profitability of homegardens, farmers are adopting alternative livelihood options including clearing of shade trees for sale of timber, cultivation of alternative cash crops like Vanilla and organic coffee farming. These resulted in increase in mixed crops cover 54.04% in 1995 - 2013 as indicated in Table 7 above.

Moreover discussion with elders revealed that there are fewer trees in homegarden than before. In a study to determine the effect of replacing indigenous species with exotic ones, Kisanga (1998) observed that despite some advantages, the introduced tree species have not replaced the total land cover that the natural vegetation covered which has resulted in an increase in bare land by 10.99% in 1995 – 2013.

Cooperatives as formal institutions that facilitate intensification have played a big role by supporting farmers in terms of making inputs available to them and establishing markets as revealed through discussion with Kilimanjaro Native Cooperative Union (KNCU) workers. The cooperatives were able to buy inputs in bulk at subsidized prices from well-known suppliers and thus helped to reduce production costs for the coffee growers. They also established reliable markets for their members so as to cushion them in years of low demand. This in turn encouraged farmers to clear more land for planting more coffee trees. However fluctuating coffee prices on the world market and the rise of production costs, have forced many farmers to shift from coffee production to horticultural crop production and other income generating activities (Lambrechts *et al.*, 2002) which resulted in a decrease in homegarden cover 70.42% in 1995 – 2013.

As land is getting scarcer due to increase in population, even the most marginal land is being brought under cultivation. In many places riverbanks have been cleared to water's

edge (Kisanga, 1998) and riverine vegetation is in danger of disappearing since it decreased by 20.44% from 1995 to 2013 despite the by-laws. Farmers need to devote their efforts to firewood and fodder production including growing their own timber and medicinal trees. But with limited priority is given to food crops as verified by an increase of mixed crops cover by 54.04% from 1995 to 2013.

The extent of forest coverage on the upper boundary of the study area has remained approximately the same over the study period. This area belongs to the "Half-mile zone" which is part of the Kilimanjaro forest reserve. Local people are allowed to collect fallen branches for firewood and fodder for livestock from the area. Even if the forest edge has stayed approximately in the same place in the study area, a survey reveals illegal logging, burning of forest, cultivation, landslides and quarries in the protected forest reserve (Lambrechts *et al.*, 2002) which result into decrease in forest cover by 0.91% in 1995 - 2013.

4.3 Socio-economic Factors Affecting the Production Performance of Chagga homegardens

The analysis involved socio-economic factors influencing volume of milk marketed as a proxy of homegarden production performance. Multiple regression model fitted to the data as shown by the computed model R^2= 0.687and the value of adjusted R^2=0. 644. The variance inflation factor (VIF) was employed to test the existence of multicollinearity problem among explanatory variables. VIF shows how the variance of an estimator is inflated by the presence of multicollinearity (Gujarati, 2003). All values were less than 5 which indicate absence of multicollinearity problem among independent continuous variables. The observation as can be observed from the result in Table 9, out of 8 hypotheses explanatory variables only distance to market, small business, education level,

extension services and number of milked cow were found to be significantly influencing the household volume of milk marketed and the remaining variables namely family size, access to loan and age of respondent were not significant.

Table 8: Results of the multiple regression models of selected predictors

Variable (X_i)	β	S.E	t	Sig.
Constant	-13.691	3.075	-4.452	.000
Distance to market	-.168	0.243	-2.069	.027*
Small business	-.066	.040	-2.632	.044*
Age of respondent	-.047	.070	-.671	.135
Education level	1.962	0.900	2.180	.031*
Family size	.550	.225	1.444	.106
Loan for homegarden production	-.056	.075	-.745	.459
Extension services	.111	.043	2.585	.010*
Number of milked cow	1.810	.140	12.967	.000*

R^2=0.676 Adjusted R^2=0.662
*Significant at 5% probability level

4.3.1 Socio-economic factors enabling the production performance of Chagga homegarden

4.3.1.1 Education level

Level of education significantly enhanced the volume of milk marketed at 5% probability level. This implies that a family with a formal educated household head will supply higher quantity of milk compare to family with uneducated household head due to the fact that the household ability to acquire new idea production related and market information increases , which in turn improves productivity and thereby increase marketable supply. A household head with formal education was found to market more liters of milk by a factor of 1.962.

The survey results also show that about 22.7% of the sample respondents were illiterate while 52% were able to read and write, 25.3% had some vocational training either in a

school or on-the-job training. Vocational training is typically in the fields of farming, carpentry, mechanics and tailoring. There were four respondents among the 75 interviewed who had diploma or higher level education. These were in the fields of education, agriculture and forestry.

Table 9: Distribution of respondents according to level of education

Education status	Frequency	Percent
No formal education	17	22.7
Middle school/standard seven	39	52.0
Other training	19	25.3
Total	**75**	**100**

4.3.1.2 Extension services

Access to extension services was found to have positive effect on volume of milk marketed and statistically significant at 5% level. The positive and significant coefficient at 0.111 of extension service pictures that the household with access to extension service be directly related to engagement in milk production through adopting improved technologies hence more supply of milk to the market. Furthermore the survey results show that 20% of the respondents have been visited by the extension agents as indicated in Table 10.

Table 10: Distribution of respondents according to any visit by extension agent since last three farming years

Contact/visit by the extension agent.	Frequency	Percentage
Yes	15	20.0
No	60	80.0

school or on-the-job training. Vocational training is typically in the fields of farming, carpentry, mechanics and tailoring. There were four respondents among the 75 interviewed who had diploma or higher level education. These were in the fields of education, agriculture and forestry.

Table 9: Distribution of respondents according to level of education

Education status	Frequency	Percent
No formal education	17	22.7
Middle school/standard seven	39	52.0
Other training	19	25.3
Total	**75**	**100**

4.3.1.2 Extension services

Access to extension services was found to have positive effect on volume of milk marketed and statistically significant at 5% level. The positive and significant coefficient at 0.111 of extension service pictures that the household with access to extension service be directly related to engagement in milk production through adopting improved technologies hence more supply of milk to the market. Furthermore the survey results show that 20% of the respondents have been visited by the extension agents as indicated in Table 10.

Table 10: Distribution of respondents according to any visit by extension agent since last three farming years

Contact/visit by the extension agent.	Frequency	Percentage
Yes	15	20.0
No	60	80.0

4.3.1.3 Number of milked cow

Number of milked cow has positive relationship with household milk marketed and was statistically significant at 5% probability level. The positive and significant relationship between volume of milk marketed and number of milked cow with coefficient of 1.810 indicates that marketable milk surplus per day increases in response to the increase in milking cow number.This increase encourages household to continue to participate on homegarden management. This result suggests that marketable milk surplus of the household in the study areas are more responsive to number of milked cow.

4.3.2 Socio-economic factors constraining the production performance of Chagga homegardens

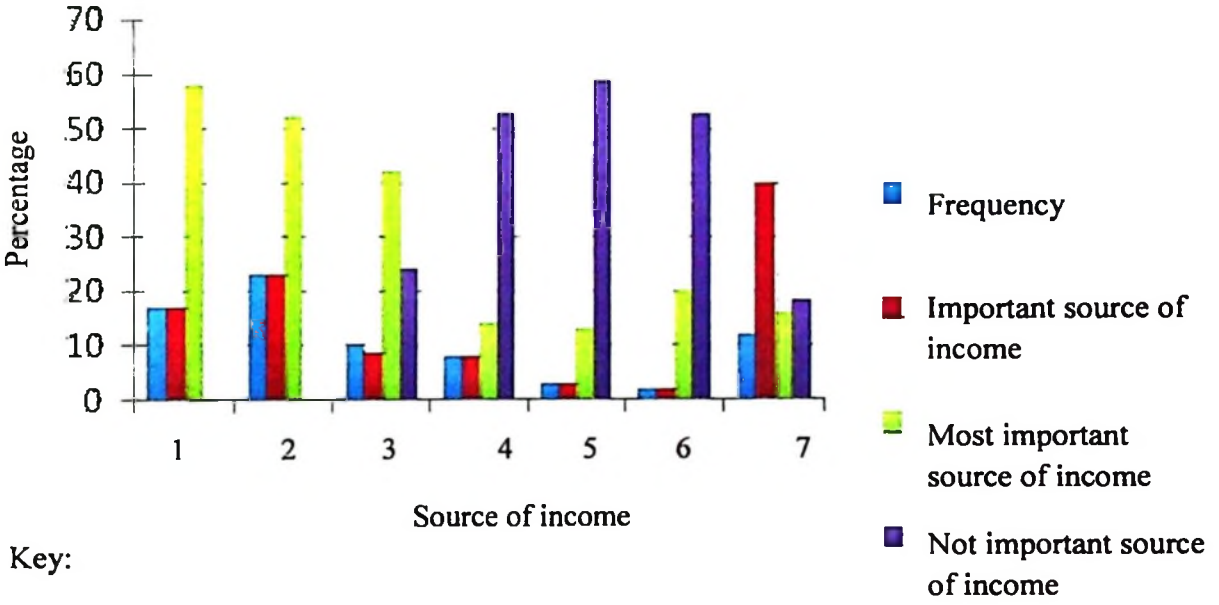
4.3.2.1 Distance to market

As hypothesized the multiple linear regression output variable was significantly at 5% significant level, a negative coefficient of 0.168 implies that an increase in 1 km distance to the market cause a decrease in household market participation by 16.8% and so decrease the quantity of milk supplied to the market by a household. The implication of the above is that for the households living close to the milk collection centers sell their produced milk more often than those living far from those centers.

4.3.2.2 Small business

Small business has a significant and negative effect at 5% probability level on the volume of milk marketed. This implies that having a small business as non-farm activities would decrease the household participation in homegarden management by coefficient of 0.066 hence decrease the quantity of milk supplied to the market by 6.6%. The survey results also show that about 50% of respondents are engaged in farming, 49.3% of the

respondents are engaged in off-farm jobs, either casual or permanent to supplement farm income. This show that there decrease in labour to perform homegarden management.



Key:

1. Sales of crops
2. Sales of livestock products
3. Sales of forest products
4. Beekeeping
5. Small business
6. Employment
7. Remittances

Figure 10: Distribution of respondent according to main source of income and the rank of importance

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the findings the study draws the following conclusions. Many local institutions exist in the study area which includes leadership, conflict resolution, land and livestock based, health and beliefs and recreational institutions. Most of these institutions with diverse functions, but all seem to relate directly or indirectly to management of Chagga homegarden. Local institutions are important structures that guide the lives of local communities. The history trend shows a decline in importance of informal institutions specifically traditional beliefs and sacredness of different items and activities including the homegardens, and decrease in importance of labour-sharing, mutual assistance and traditional dance institutions due to influences from modern religion and new technologies. However, despite the advent of modernity and formal institutions, local informal (traditions) institutions remain relevant to management of Chagga homegarden. They provide a basis for exploitation for their potential to complement formal institutions. For the sustainability of Chagga homegardens local leadership from the informal institutions can influence key decisions that could help enforce formal institutions.

The Chagga homegarden has undergone some changes which resulted into land cover change between two periods 1987-1995 and 1995-2013. In the first period 1987-1995, despite an increase of homegarden cover by 30.1%, 32.12% of the total homegarden cover was transformed into settlement cover 30.12% was transformed into riverine vegetation, 35.08% was transformed into mixed cropland, 32.15% was transformed into agriculture field, and 38.01% was transformed into forest cover while 33.82% was transformed into bare land. During 1995-2013 homegarden cover decreased by 70.42% a

trend that is likely to disappearance of homegarden in some foreseeable future. The decreases of homegarden cover reveal an increase of other land use types which resulted into other land cover types. In this period, Settlement cover is among the land cover which increases by 30.24% resulted from increase in population which resulted into an increase in bare land by 10.99%. As a result of coping with the situation of decreasing homegarden productivity farmers engaged in mixed crops production hence an increase of its cover by 54.04%.

Education level of household head, access to extension services and number of milked cow were found to be the socio-economic factors positively influencing the production performance of Chagga homegarden while distance to the market and small businesses were the constraining factors to production performance of Chagga homegarden.

5.2 Recommendations

The traditional agroforestry systems (homegardens) together with the rich indigenous ecological and management knowledge can provide solutions to many agricultural challenges that we are facing today including food insecurity and the impacts of climate change.

i. Homegarden land use systems should properly be identified and promoted to tap the rich indigenous knowledge and skills that were used in balancing and sustaining agricultural production with environmental conservation. Since agroforestry generates significant public environmental services such as watershed protection, biodiversity, and carbon sequestration there is need for the government to provide incentives to the private sector to get involved in promotion of Chagga homegarden practices.

ii. Indigenous species in a given area should be well defined and properly documented and archived in order to give guidance and inform farmers on its importance through conducting research and establishing indigenous tree nurseries. The selective custodian and passage of this rare and vital knowledge has relied on word of mouth and it is likely that most of it may have been lost with the death of individuals who possessed it.

iii. Moreover, Informal legal systems have worked well in the past and one way of backing up local institutions is to encourage interaction between them and formal institutions involved in homegardens management, therefore there is a need to integrate aspects of traditional governance system into the formal system through incorporation of traditional rules into formal systems of Chagga homegarden management, so as local informal institutions not to be a thing of the past. In the study area, each village has natural resources and environmental management committee under the Village Government. Such committees should make use of local institutions like mutual assistance, traditional leaders and traditional dance groups in creating awareness on management of homegardens including water shed protection and soil conservation.

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APPENDICES

Appendix 1: Household questionnaire

Section 1: General information

1. Name of village _____
2. Date of interview _____

3. Name of Respondent	2.Gender	3.Age	4.Marital status	5.Level of educational	6. Family size

Code:

- Gender 1=Male, 2 =Female
- Marital status 1= Married, 2 = Single, 3 = Widowed, 4= Divorced
- Level of education, Number of years in school

  1=No formal education 2=Middle school / Standard 3=Form six

Section 2: Status of land uses characterize Chagga homegarden

4. How long did you spend on farming _____

   1=Permanent 0=Seasonal

5. Do you have any other work than farm work? 1=Yes ( ) 0=No ( )

   If yes specify _____

6. Name the most important tree/shrub species that are common in your farm

   (Give local names) Ask an older member of the household)

   _____ _____ _____

7. Which species mentioned above would have been the most common 20 years ago?

   _____ _____ _____

8. Name 3 tree species that are no longer being planted on farm as a result of development

_____ _____ _____

9. What are the main sources of income in the household?

Main source (MS) (Tick)	Rank [1]
1. Sale of crops	
2. Sales of livestock/livestock products	
3. Sale of forest products	
4. Beekeeping	
5. Small business	
6. Employment	
7. Remittances	

1 most important 2 important 3 not important

10. List the major changes that are taking place over time

Crops	No. of acreage /cows			Output/Yield with time		
	2010	2011	2012	2010	2012	2013
i. Coffee						
ii. Maize						
iii. Milk						
iv. Banana						
v. Cows						

11. If there are changes what is the reason for changes. _____

Section 3: Assessment of institutions and homegarden resources

12. How much acres do you cultivate for the past 20 years. _____

13. What is the new farming technology have you adopted_____

14. What are the most common methods of obtaining land in your community?

Method of obtain land	**(Rate them in order of highest occurrence, 1-5).**
Inheritance	
Renting	
Purchasing	
Borrowing	
Others (Specify)	

1 the most common and 5 the least common

15. What and how much inputs do you receive from any institution for the last farming season?

Input	Quantity	Price	Name of institution
Seeds			
Fertilizer (type)			
Pesticides (type)			
Herbicides			
Others (specify)			

16. Are there institutions responsible for utilization of forestry resources?

If yes, what institutions?

17. Are you belonging to any formal/informal social group?

1= Yes ( ) 0= No ( )

If yes, mention them_____

18. How is the access to forest resources today as you compare with the past? _____

19. . Have you been visited by an extension agent(s) since last farming season?

1=Yes ( ) 0=No ( )

If yes, how many times in a year_____

20. Which activities do you consider as a new farming technology? _____

21. Have you obtained any loan for homegarden production from anybody / institution?

1= Yes ( ) 0= No ( )

If yes, How much? _____

22. If yes, did you use any part of the credit for purchasing inputs for homegarden production?

1= Yes ( ) 0= No ( )

23. Is this loan easily obtained 1.Yes ( ) 2.No ( )

If No, why? _____

24. What season of the year do you need loan mostly?

1) During the planting season ( ) 2) After the planting season ( )

3) Before the planting season ( )

25. Do you sell any of your homegarden products in the market? Yes ( ) No ( )

If yes, How often?

a) Every week ( ) b) Every month ( ) c) Twice a month ( )

26. How accessible is the market? ( ) 0= very near 1= very far

27. What proportion of total agriculture and animal product is consumed at home?

	All used at home	Mostly used at home	Half used, half sold	Mostly sold	All sold
Coffee					
Banana					
Maize					
Milk					

28. What are the constraints/problems you face on the practice of agriculture/animal production on your homegarden? _____

29. How do you generally compare the present and the past and how do you project the future with regard to utilization of homegarden resources. _____

30. What should be done by government in order to enable you to manage your homegarden?

_____

31. Institutions have contributed on the performance of chagga homegardens.

1.Strong agree	2.Agree	3.Neither agree nor disagree	4.Disagree	5.Strong disagree

THANK YOU FOR YOUR COOPERATION

Appendix 2: Checklist for focus group discussions

i. What is Chagga homegarden?

ii. What are the local institutions available in Chagga community?

iii. Which are the roles of local institutions available in Chagga community?

iv. Which are the roles of local institutions in management of Chagga homegardens?

v. What should be done to local institutions for sustainable management of Chagga homegardens?

vi. Which are the current land uses in your village?

vii. Which land use changes have been observed in the past 30 years?

viii. What could be the reasons for the above land use changes?

ix. What are socio-economic factors underlying management of Chagga homegardens?

x. What are the effects of those factors on homegarden performance?

xi. How do you rank the performance of homegarden?

xii. What are the bottlenecks for sustainable management of Chagga homegardens?