ASSESSMENT OF THE STATUS OF AGROFORESTRY PRACTICES IN MVOMERO DISTRICT, MOROGORO, TANZANIA

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

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ABSTRACT

The present study on assessment of the status of Agroforestry practices adoption in Mvomero District, Morogoro, Tanzania. The study was conducted during September 2020 to December 2021 at Dihombo, Hembeti and Mkindo villages in Mvomero ward. Mvomero with its three villages were purposively sampled, and then thirty households from each village were randomly selected to make a total sample of 90 households, Data collection was done through reconnaissance survey, questionnaires, checklist of probe questions and field survey. Data were analyzed by descriptive statistics and inferential statistics with the aid of Statistical package for Social Science (SPSS). The results indicated that Agriculture contributes more than Agroforestry in terms of food and income generation. Also when the Data analyzed descriptively on the contributions of Agriculture and Agroforestry on fire wood and charcoal to the people, it found that, there were very small differences in contribution between Agroforestry ad Natural forest, but on further inferential statistics it found that, there were no significance in differences contributions of fire wood and charcoal as a source of energy between Agroforestry and Natural forest, both used as sources of fire wood and charcoal. From results, it is important to increase efforts on the promotion of the Agroforestry so as to increase on the adoption of Agroforestry which then will help to increase the wide range of food production and will reduce the uses of the fire wood and charcoal from the Natural forestry which then reduces the environmental destruction by cutting down trees as a sources of firewood and charcoal. Also factors that can enhance adoption of agroforestry were analyzed descriptively, the results shows almost all factors were on the similar percentage, also factors which limit the adoption of the agroforestry ware in similar percentages, So all of the factors that enhance adoption of agroforestry and those which limit adoption of agroforestry should be taken in consideration in order for improvements of the agroforestry.

DECLARATION

I, EMMANUEL M. MWAKALALILE, do hereby declare to the Senate of the Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor is being concurrently submitted to any other institution for similar purpose.

_____ _____

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The above declaration is confirmed by:

_____ _____

Prof. L. L. L. Lulandala Date

(Supervisor)

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DEDICATION

I dedicate this valuable work to my parents, Mr. and Mrs. Mwakalalile.

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LIST OF ABBREVIATIONS

AEO	Agriculture Extension Officer
ANOVA	Analysis of variance
DALDO	District Agriculture and Livestock Development Officer
DNRO	District Natural Resources Officer
GDP	Gross Domestic Product
Ha	Hectare
HH(s)	Household(s)
Hrs	Hours
Kg	Kilogram
KM	Kilometre
LSD	Least Significant Difference
NGOs	Non-Governmental Organizations
0C	Degree Celsius
SED	Standard Error of Difference
Sq Km	Square kilometer
SUA	Sokoine University of Agriculture
URT	United Republic of Tanzania
VEO	Village Executive Officer
WALEO Ward	Agriculture and Livestock Extension Officer
WFO	Ward Forest Officer
AF	Agroforestry

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Agroforestry has been defined as a dynamic ecologically based natural resources managements system that involves integration of trees on farms and in the agricultural landscape that diversifies and sustains production for increased social, economic and environmental benefits on the same piece of land (Alao and Shuaibu, 2013).

Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the world. The history of Agroforestry shows that in Europe, until the Middle Ages, it was the general custom to clear-fell degraded forest, burn the slash, cultivate food crops for varying periods on the cleared area, and plant or sow trees before, along with, or after sowing agricultural crops. This "farming system" is no longer popular in Europe, but was widely practiced in Finland up to the end of the last century, and was being practiced in a few areas in Germany as late as the 1920s (Nair, 1993). In Tanzania, Agroforestry has been practiced in many areas, for a long time, traditionally and even in modern ways. Examples include the Chagga home gardens, the related Mara Region homegardens known as Obohochere and the Wasukuma Silvopastoral technologies called Ngitili (Kitalyi *et al.,* 2013).

Agroforestry practices offer practical ways of applying various specialized knowledge and skills on the development of sustainable rural production systems (Alao and Shuaibu, 2013). Therefore, the people in the area can adopt Agroforestry systems more to curb the problems related to hunger, poverty and environmental stress (Mkonda and He, 2017). There is a great demand for optimal production of food by today's global population where the production needs to be not only high, but also stable and sustainable.

This type of production is required urgently to feed the millions of undernourished people in sub-Saharan Africa. However, this type of food production necessitates good farming systems that can optimally increase yields to curb hunger and famine in the region. In this respect, Agroforestry which has a number of economic, social and ecological significance is seemingly to be the solution since it has significantly increased stable yields in various areas where it was adopted (Mkonda *et al.*, 2017).

1.2 Problem statement and justification

1.2.1 Problem statement

Tanzania is one among countries which his farmers depends on rain fall as sources of water for agriculture and livestock keeping activities, and by doing so they are high affected by the global climate change. Mvomero District is one among Districts in Morogoro region, which is among vulnerable Districts on climate change because of high dependence on climate sensitive livelihood activities (Magita, 2017). Also due to climate change, there are some semi-arid regions with shortage of food due to inappropriate farming methods or not including Agroforestry practices in food production on those areas, so due to that there are some researches done on the identification of the Agroforestry practices in some areas such as (Baha, 2017). The status of Agroforestry practices in Hanang Ditrict, Manyara Region, Tanzania, (Chija, 2013) Adoption Status and Management of Agroforestry Systems and Technologies by Communities: A Case Study of Kasulu District, Kigoma, Tanzania and (Rojas *et al.*, 2020) Factors Affecting the Adoption of Agroforestry Practices: Insights from Silvopastoral Systems of Colombia. The obtained findings of Agroforestry adoption practices from those studies provides the recommendations based on the status found in such study areas. But the degree of adoption of Agroforestry practices differs from one area to another due to the non-common factors which can affect the Adoption of the Agroforestry practices,

However, more research has to be done so as to know the existing status of Agroforestry practices in the various part of country so as to take measures based on the obtained findings in relation to methods of food production, farming systems that can optimally increase yields environmental friend, and improving sustainability of Agriculture..

1.2.2 Justification of the study

The findings of the study contribute to availability of the information concerning the ground status of the Agroforestry practices which gives way to Government and Non-Government organizations to know the gaps that exist in knowledge, and are able to estimate the effort required in scaling up the Agroforestry practices in various areas. Also generated findings would contribute to the availability of knowledge for the general public, academicians, and the government institutions for better understanding of the potentials of the Agroforestry in environments and sustainability in production and natural resources used in production. Policy and decision makers will make use of the findings from these studies including the present one, in devise short-term and long term strategies for sustainable Agroforestry development and management.

1.3 Objectives

1.3.1 Overall objective

Assessment of the current status of Agroforestry practices in Mvomero District, Morogoro region.

1.3.2 Specific objectives

The specific objectives of the study were:

(i) To determine the extent of Agroforestry adoption by the local communities in the study area.

(ii) To identify the Agroforestry systems and technologies in use in the study area

(iii) To determine the contribution of Agroforestry to the livelihoods (food, income and wood energy supply) of the local communities in the study area.

(iv) To determine the factors that influence Agroforestry adoption and mechanisms that would enhance it in the study area.

1.5 Research questions

1. What is the current status of Agroforestry adoption in the study area?
2. What are the Agroforestry systems and technologies that are adopted in the study area?
3. What is the contribution of Agroforestry to the livelihoods (food, income and wood energy) of the local communities in the study areas?
4. What are the factors that enhance the Agroforestry adoption and mechanisms that would enhance it in the study area?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Extent of agroforestry adoption

Adoption is a state of acquiring and initializing a certain innovation. It's a situation whereby someone has decided to apply a certain technology than other corresponding technologies. Extent means the attained level of the adoption of the acquired innovation. The adoption occurs when one has decided to make full use of the new technology as the best course of action for addressing a need. Generally, the adoption is determined by several factors including socio-economic, environmental, and mental processes that are governed by a set of dominant variables such as individual needs, knowledge about the technology and individual perception about methods used to achieve those needs (Baha, 2017). The National Agroforestry Strategy prepared in 2004 envisions at least four million rural households adopting and benefiting from Agroforestry practices in a sustainable manner by 2025. Its goal is that by 2020, Agroforestry technologies are adopted and contribute to improved livelihood of 60% of resource poor households in the country. This goal complements the national development strategy framework "MKUKUTA", which emphasizes poverty reduction and increasing household income while conserving the environment (Kitalyi *et al.,* 2010).

2.2 Agroforestry systems and technologies

2.2.1 Agroforestry systems

Agroforestry has risen to prominence as a land-use strategy to help address global climate change and provide other environmental, economic, and social benefits. However, systematic knowledge on the human–environment impacts of agroforestry practices and interventions remains lacking. Agroforestry is promoted for its potential for carbon

sequestration, soil erosion and runoff control, and improved nutrient and water cycling, as well as for offering socio-economic benefits and greater agricultural productivity. The mixture of components creates an agroforestry system in which the components interact in a beneficial manner (Brown, 2018). Also agroforestry is a collective name for resources-use systems and technologies in which woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately integrated on the same resource-management units as Agricultural crops and/or animals or insects and aquatic life form in some form of spatial arrangement or temporal sequence. In Agroforestry systems there are both ecological and economical interactions between the different components (Nair, 1993). Classification of Agroforestry systems had been based on the three components of traditional resource-use sectors of agriculture, forestry and animal husbandry with the trees/shrubs, crops and animals being their respective components. Based on such component criterion, Agroforestry was earlier classified into three broad systems of Agrosilviculture (Agrosilvicultural system), Silvopasture (Silvopastoral system) and Agrosilvopasture (Agrosilvopastoral system) depending on the components that were forming the interactions (Shilabu, 2008). Agroforestry systems aim to maintain or increase production (of preferred commodities) as well as productivity of the resources use systems. Agroforestry can improve productivity in many different ways, these include: increased output of the tree based products, improved yields of associated crops, reduction of cropping system inputs, and increased labor efficiency (Nair, 1993). By integrating trees, wood perennials, livestock into a conventional annual cropping agricultural system, agroforestry promotes the efficient use of sunlight, moisture, plant nutrients, and other ecological services for increased ecological, economic and social benefits. The integration of crops, livestock, insects, aquatic life forms and tree species has implications for sustainable agricultural practices, improved product diversification, improved human nutrition, reduced system risk and instability, labor equity and increased use of renewable

resources. The ecological benefits of successful agroforestry systems include improved soil health, reduced microclimate extremes and increased rates of biodiversity. This resource management system aims to reduce risk and increase total productivity while also providing specialized socioeconomic services to individual farmers and their communities (Shapiro and Frank, 2016).

2.2.1 Agroforestry technologies

Depending on the basis of how the various Agroforestry components are arranged or structured on the resources management unit, the Agroforestry systems can be further sub-divided into sub-systems called Agroforestry technologies. The choice on which or how a set of components in a particular Agroforestry system should preferably be arranged on the resources management unit, is not made randomly. It should always be based on a sound; thoroughly considered criterion intended to address an environmental-related factor such as soil conservation, ecological amelioration and Agro-meteorological influences (Baha, 2017). Example, (Asempah, 2014) the main agroforestry based technologies for climate change adaptation include improved fallows, Taungya (growing annual agricultural crops during the establishment of a forestry plantation), Alley cropping, growing multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture and apiculture with trees.

Also Agroforestry technology refers to an innovation or improvement, usually through scientific intervention, to either modify an existing system or practice, or develop a new one. Such technologies are often distinctly different from the existing systems/practices; so they can easily be distinguished and characterized (Nair, 1993).

On the basis of these criteria various Agroforestry technologies can be used in any of the Agroforestry systems, either singly or in combination of two or several of them, depending on the conditions that prevail over the area over which an Agroforestry intervention is intended. The most commonly used Agroforestry technologies includes: Taungya, Homegarden, Alley farming, Hedgerow intercropping, Relay farming, Rotational cropping, live fences, Mixed intercropping, Contour-ridge planting, Shelterbelt and Windbreak planting (Nair, 1993).

2.3 Contribution of Agroforestry to the livelihoods (food security, income and wood energy) of the local communities

2.3.1 Contribution of agroforestry to the food security

Food security is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Four dimensions of food security have been identified in line with different ways which are as, Availability at National level, Accessibility at household level, Utilization by Individual level and Stability that may be considered as a time dimension that affects all the levels. All four of these dimensions must be intact for full food security (Peng *et al.,* 2019). Increasing pressure of human and livestock population are the main causes of natural resource degradation. Agroforestry systems such as Agri-silviculture, Agri-horticulture, Silvipastoral, Agri-silvi-pastoral and other systems like Aqua forestry, Apiculture with tree species may increase food production with natural resource conservation and their efficient utilization. Through diverse food production, natural resource conservation, improving nutrition, health and increasing economic income of rural poor people, agroforestry play an important role in country's food security (Sarvade *et al.,* 2014).

Solving the problem of food and nutritional security requires among other interventions a range of interconnected agricultural approaches, including improvements in staple crop productivity, the bio- fortification of staples, and the cultivation of a wider range of edible plants that provide fruits, nuts, vegetables, etc., for more diverse diets (Jamnadass *et al.*, 2013). Potential for the diversification of crop production lies in the great range of lesser-used indigenous foods found in forests and wooded lands that are often richer in micronutrients, fiber and protein than staple crops (Jamnadass *et al.,* 2013).

2.3.2 Contribution of agroforestry to the income and livelihoods

Agroforestry plays a significant role in increasing agricultural productivity. In South Africa, there is a pressing need for promoting smallholder agriculture to promote sustainable rural livelihoods, to ensure food security, to lower inflation in food prices, and address rampant rural unemployment in the country. Agroforestry contributes to sustainable rural livelihoods in South African provinces where the predominant means of livelihoods is rural subsistence farming and agriculture (Zerihun, 2021).

Study by (Regmi, 2003) explain the contributions of Agroforestry on the livelihoods and income of people by showing issues such as, fuel and fodder requirements of continuously increasing human and livestock population have generated enormous pressure on forest and arable land, leading to depletion of natural resources thereby affecting natural and human environment. Literature indicates that forest resources are dwindling day by day in quantity, quality and diversity. It has been estimated that forest in Nepal in 1964 was more than 45% of the total land area. In 1979, forest cover reduced to 43%. By 1986, forest had been further been reduced to 37.4% and by 1998 to 29% of total land area. This has a considerable impact on women and girls, who are responsible for fetching water and collecting fuel wood in rural areas. In this context Agroforestry can

play a vital role to meet the need of the growing population in terms of sustaining crop agriculture and livestock, production of commodities for exchange and as a form of energy and providing diverse tree products for sustaining rural livelihoods. A review of approaches on farm tree management practices by farmers conclude that trees in farming systems are not seen as their farmers see trees in terms of how they contribute to their livelihood needs and strategies. On the other hand Agroforestry practices play a great role in income generation as it uses multiple components that produce diverse products. Income from Agroforestry practices comes from selling cereals crops, fruits, vegetables and other cash crops (Baha, 2017).

2.4 Contribution of Agroforestry to the Wood Energy Supply

Wood fuel plays a critical role in energy provision in sub- Saharan Africa and is predicted to remain dominant within the energy portfolio of the population to the future (Jamnadass *et al.,* 2013), also cooking has been one of the biggest leaps forward in human history, and as trees often provide the fuel required, a close association between crops and trees to make sure there's something in the cooking pot and something to heat it (in other words: forms of agroforestry) has been as old as agriculture. When crop fields were scattered in a vegetation of recovering fallow plots, one didn't have to walk far to find firewood, but when cropped fields became contiguous and fallow periods short, maintaining firewood supply required specific efforts. In parts of the world hedgerows developed that combined functions in keeping straying animals from cropped fields, with microclimate effects and provision of wood for farm implements and as fuel **(**Miyuki *et al.,* 2014). Traditional European agroforestry had strong rationale in wood energy security, an aspect recently gaining attention through emission accounting rules14. Energy is used for many aspects of modern lives, with cooking probably as oldest invention, requiring control over fire and its fuel (Meine *et al.,* 2019). Also much has been reported about the fuel wood

demand and shortage problems. This essential resource is seriously threatened and the developing world is facing a critical wood energy shortage seriously as the petroleum crises. If Agroforestry, is widely adopted as an integrated strategy together with improved kilns and stoves, can have a significant impact to reduce wood harvest pressure in forests through sustainably supplying trees on farm (Baha, 2017).

2.5 Factors that influence the agroforestry adoption and mechanisms for its scaling up

Adoption of technological innovations in agriculture has received considerable attention among development economists because new technologies seem to offer opportunities to increase production and income substantially. But the introduction of many new technologies has met with only partial success, as measured by the observed rates of adoption The conventional wisdom is that the constraints to rapid adoption of innovations involve factors such as the non-availability of credit, limited access to information, small farm size, farm tenure arrangements, high risks, inadequate and untimely supply of complementary inputs (such as seed, chemicals and irrigation water), and poor infrastructure (Sharma and Kumar, 200). Sometimes, farmers do not adopt because the technology does not fit with existing practices. Farmers‟ involvement in new technologies requires tradeoffs with other activities from which they currently generate their livelihood and if the new technology does not fit with them, they will hesitate to take it up. There are certain technology specific factors that influence adoption decisions which are attributes that farmers look for in a technology before they can apply it as relative advantage; trialability, observability, compatibility and complexity (Kabwe1 *et al.*, 2016).

Also there is other the major factors affecting adoption of agroforestry fall into two main categories of socioeconomic and biophysical factors. The factors are high initial costs of agroforestry practices, low extension knowledge unavailability of agroforestry germplasm for economic, social and biophysical categories respectively. Also awareness of the connection between agroforestry and land quality improvement could lead to wide scale adoption of the technology. For improvements or scaling up of the Agroforestry adoption Government policies my strongly influence adoption of agroforestry technologies. There is need to institutionalize sustainable agricultural land management practices through policy formulation, budgetary allocation for extension officers and farmer training and starter up inputs. Promotion of agroforestry should be coupled with investment in awareness creation, farmer-centered approaches in selection of technology and provision of inputs in the initial stages. Strong collaboration among policy makers, researchers and extension providers will be required to harmonies messages to be delivered to farming communities (Baha, 2017).

Since that, National Agroforestry Strategy prepared in 2004, emphasize more on the increasing in adoption of the Agroforestry practices and benefits by rural people (Kitalyi *et al.,* 2010), the adoption of Agroforestry practices will increase as effort on increasing of extension cervices to rural people.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

3.1.1 Location of study area

The study was conducted in Mvomero District that is located between Longitudes 6º00’ and 8º00’ latitudes south of Equator also between longitudes 36º00’ and 38º’ East of Greenwich (Figure 1). The District has the total area of 7325 sq km (Kushoka, 2011). Mvomero District boundaries are as follows: to the north is Handeni district, to the east Bagamoyo district, to the south is Morogoro Municipality and Morogoro Rural District, and to the west there is Kilosa District. The study will be conducted in Dihombo, Hembeti and Mkindo villages which found in Mvomero Division, which is located in West of Mvomero District.

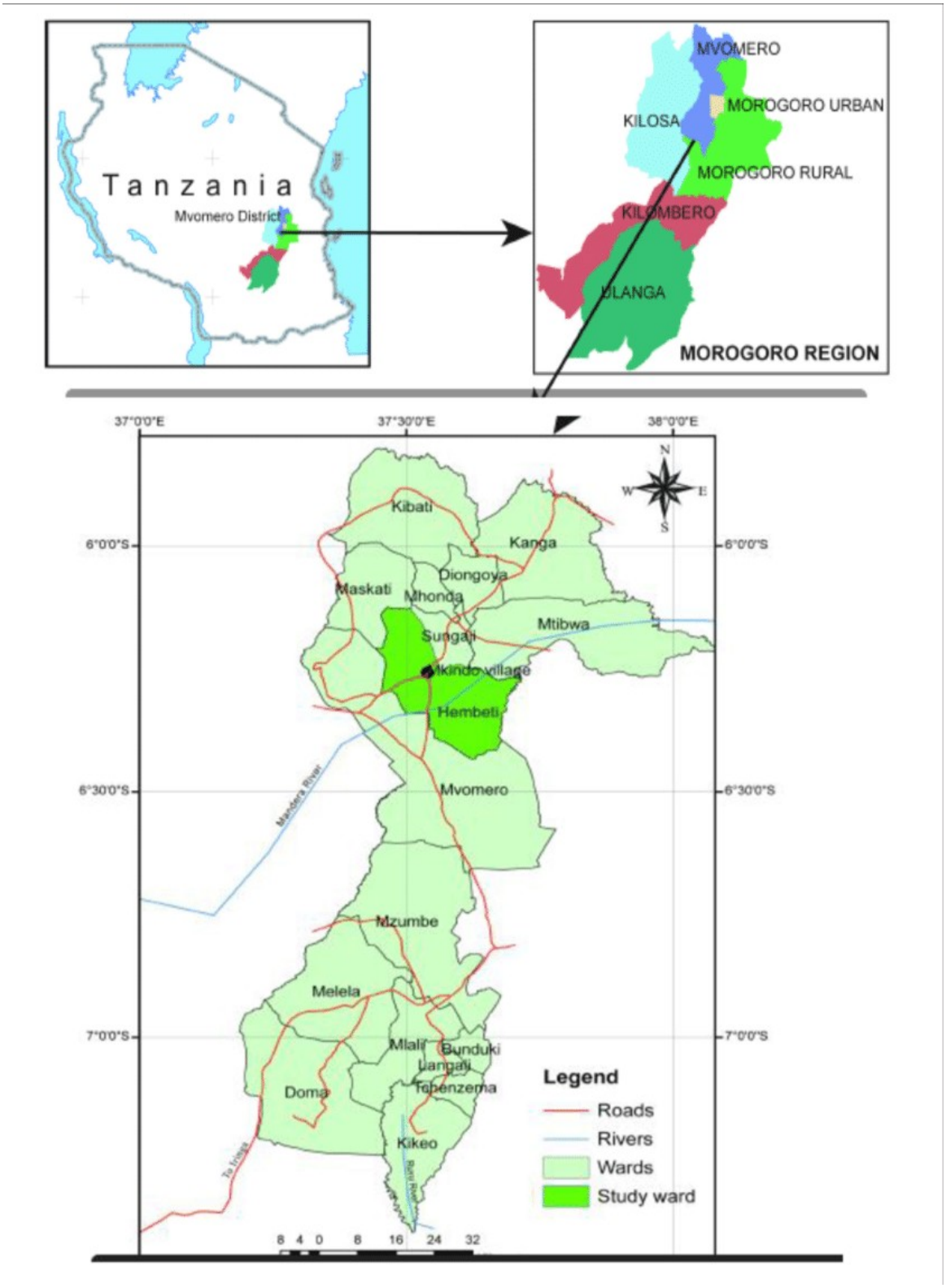

Figure 1: Location of the study area

3.1.2 Description of the study area

3.1.2.1 Climate of study area

The mean annual rainfall in the study area is approximately 1000 mm. The eastern part received about 800 mm to 1000 mm while in the inland areas towards Dodoma and north of the Wami Sub-Basin, the average rainfall is between 500mm to 600 mm per year (Mkonda, 2014).

3.1.2.2 Population characteristics

In the last national census of 2012 Mvomero district had 312 109 people of which 154 843 were males and 157 266 were females. This represented a net increase of 52 762 people over the 2002 district population which was 259 347 at a growth rate of 1.86. The average population density of Mvomero District is estimated to be 42.6 people/ km^2 while population distribution within the District depends on economic activities engaged by people, the geographical location and soil types (URT, 2017).

3.1.2.3 Land form

Mvomero District has three agro-ecological zones which are highlands and mountains (25%), Miombo woodlands (20%) and Savannah River basin line zones (55%). *https://en.climatedata.org/africa/tanzania/ Morogoro/mvomero-26721*.

3.1.3.4 Land use

Mvomero District is a highly agriculture-based economy. Nearly 5493.75sq km (75%) is arable land (URT, 2017). Nearly 82% of the working-age population is made of farmers followed by businessmen (7%) and livestock keepers (1%). The remaining 10% of the working population is engaged in other occupations (URT, 2017).

3.1.2.4 Social economics

The main economic activities are as agriculture, livestock keeping, fishing, mining, and quarrying, Trade and commerce, public administration and education, Commercial Agriculture and hunting (URT, 2017).

3.2 Methods

3.2.1 Research design

The design of the present study was descriptive and cross-sectional study that involved collection of data at one point in time without repetition from samples (Kothari, 2008). It was a descriptive study because it sets out to vigorously describe adoption of Agroforestry practices in the study area (Baha, 2017). The rationale for the choice was based on the fact that the design allows collection of data on different groups of respondents at one point of time (Mwasha, 2016).

3.2.2 Sampling techniques

Purposive sampling technique used to select three villages of Mvomero Division. A random sampling technique used to select households; random sampling was used to avoid researcher's biasness and to provide an equal opportunity for each household to be selected as a sample to provide essential information (Kothari, 2008). The sample size of 30 household was selected randomly from each village to make a sum of 90 household. Since that, According to Adler and Adler (1987), it is suggested that sample size should range between 30 and 60, with 30 being the minimum total respondents, but more respondents may be involved in the study when sub-populations are discernible within the setting and it is likely that members of these groups have varied perceptions, roles, statuses, problems with, or decisions about the scene.

3.2.3 Data collection

3.2.3.1 Reconnaissance survey

(a) Primary data

Primary data collection was preceded by a reconnaissance survey as pilot study, which aims at providing a general picture of the study area to the researcher. The researcher was able to introduce himself and introduce the intention of the study to the leaders and villagers. The researcher was able to select sample wards and villages at random. Through this survey, identification of various people of interest or groups available in various areas of the study such as, Village Executive Officer, extension officers and Key informants were done.

(b) Social Survey

In this study, primary data for both qualitative and quantitative data was collected through formal survey by using both structured and semi-structured questionnaires (Appendix 1). Structured questionnaires which contained both closed and open ended questions will be used to collect primary data for the study. Data collected through this method includes general information, demographic information, Land use and land size, household composition, education levels, Agroforestry systems and technologies in use, products collected from Agroforestry components, factors which influenced adoption of Agroforestry and finally data on measures required for improving the adoption of Agroforestry practices in the study area also collected. Observations were done so as to verify and supplement the information collected during household's survey and key informant's interviews. Documentation of observed systems and technologies was done through photographing.

(c) Focused group discussion

In this study, researcher visited and interviews the key informants who were District Forest Officer (DFO), District Agriculture Extension Officer (DAEO), District livestock Officer (DLO), Ward and village Agriculture Executive Officers, Ward Executive Officer, Ward Forest Officer , Ward and villages livestock Extension officers and village extension officers, who had the depth knowledge about the study objectives, checklists of probe questions (Appendix 2 and 3) used to collect information during interview.

(d) Field survey

Field survey was done through observing of the Agroforestry systems and technologies practiced by the people on the fields.

(e) Secondary data collection

Data from secondary sources obtained by consulting relevant documents both published and unpublished to form an over view and identify gaps in information. Reports from local governments' authorities collected to give information on general aspects and specific issues related to study objectives.

3.2.4 Data analysis

Both quantitative and qualitative data were analyzed with the aid of Statistical Package for Social Science (SPSS). From this software, descriptive statistics such as frequency, means and percentages were computed. Analysis of Variance (ANOVA) was carried out to determine the significance difference of adoption rate between the villages, sources that contribute to wood energy, sources that contribute to food and sources that contribute to people's income.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-economic characteristics of the respondents

The sampled households had different socio-economic characteristics as shown in Table 1. According to findings of this study, the majority of respondents, 53.3% had primary education, 26.7% had secondary education, 5.6% had college education and another 14.4% had no formal education (Table 1). 82.2% depend on farming, 8.9% depend on agro-pastoralism as their main occupation while others, 4.4% are employees in government or private offices and 3.3% depends on business as their occupation. Very few (1.1%) respondents engaged on other activities like carpentry. 67.8% of the interviewed respondents were men while only 32.2% were female. The largest proportion (51.1%) of the respondents were in the age group of 46 years and above followed by 31.1% age group of 36-45 years and 16.7% were in the age group of 26-35 while the age group of 18-25 years only makes 1.1% of the respondents. The family size of 43.3% households was 1- 4 members while 51.1% of the respondents' households had a family size of 5-8 members and the least 5.6% in family size of 9-12 members. Moreover, most respondents about 57.8% had a land size ranging from 0.25- 0.5 ha followed by 26.7% in land size group of 0.75 – 1 ha, 10% in land size group of 1.25-1.5 ha and lastly 5.6% in land size group of 1.75 ha and above.

Table 1: **Respondents and Household socio-economic characteristics**

Socio-economic characteristics		**Frequency**	**Percentage**
Education level			
	Primary	48	53.3
	Secondary	24	26.7
	Informal (None)	13	14.4
	Collage/University	5	5.6
Occupation			
	Farmer	74	82.2
	Agro pastoralist	8	8.9
	Employee	4	4.4
	Businessman	3	3.3
	Others	1	1.1
Sex of respondent			
	Male	61	67.8
	Female	29	32.2
Age range of respondent			
	18-25	1	1.1
	26-35	15	16.7
	36-45	28	31.1
	46 and above	46	51.1
Household size			
	1-4 member(s)	39	43.3
	5-8 members	46	51.1
	9-12 members	5	5.6
Land size			
	0.25-0.5 ha	52	57.8
	0.75-1 ha	24	26.7
	1.25-1.5 ha	9	10.0
	1.75 and above	5	5.6

4.2 The extent of agroforestry practices adoption by the local communities in the study area

The results on the extent of Agroforestry practices adoption by the local communities in Mvomero District are presented in Table. On average, 85.5% of the communities of Mvomero District adopted Agroforestry. In Hembeti village 93.3% of respondents and Mkindo village 83.3% of respondents were practicing Agroforestry and in Dihombo 80% of all respondent were practicing Agroforestry. Also further statistical analysis was used

to test on the adoption rates between villages. ANOVA table as Appendix 4, since ($p > 0.05$) the adoption rate of the villages was not significant different.

Table 2: Extent of adoption status of agroforestry systems in Mvomero district

Village	Adopters Frequency	Non adopters Frequency	Total frequency	Adopter (%)	Non adopters (%)	Total (%)
Hembeti	28	2	30	93.3	6.7	100
Mkindo	25	5	30	83.3	16.7	100
Dihombo	24	6	30	80	20	100

4.3 The Agroforestry systems and technologies in use in the study area

The results in Table 3 present the various Agroforestry systems adopted by the communities in different villages in Mvomero District. The average of adopted Agroforestry systems amoung all three villages was found as Agrosilviculture system 91.5%, Aposilviculture system 5.6% and Aquosilviculture system by 2.8% which was the least the adopted Agroforestry system.

Table 3: Agroforestry systems adopted in the study villages in Mvomero district

Village	Agroforestry systems	Frequency	Percentage
Hembeti	Agrosilviculture	27	90.0
	Aposilviculture	2	6.7
	Aquosilviculture	1	3.3
Hembeti Total		**30**	**100**
Mkindo	Agrosilviculture	25	88.0
	Aposilviculture	3	7.0
	Aquosilviculture	2	5.0
Mkindo Total		**30**	**100**
Dihombo	Agrosilviculture	29	96.7
	Aposilvipasture	1	3.3
Dihombo Total		**30**	**100**

4.3.1 Technologies adopted by the local communities in Mvomero district

The results on various Agroforestry technologies which have been adopted and practiced in different villages are as, presented in Table 4. The average practices of Agroforestry technologies among all three villages was as, Alley farming technology was 40%, Hedgerow intercropping technology 34.5% and Boundary planting technology 25.5%. The leading Agroforestry technologies to be practiced more were Alley farming technology followed by Hedgerow intercropping and Boundary planting.

Table 4: Technologies adopted by communities in Mvomero district

Agroforestry technologies	Hembeti		Mkindo		Dihombo	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Alley farming	9	30	14	46.7	13	43.3
Hedgerow intercropping	11	36.7	9	30	11	36.7
Boundary planting	10	33.3	7	23.3	6	20
Total respondents	30	100	30	100	30	100

4.4 The contribution of agroforestry to the livelihoods (food, income and wood energy supply) of the local communities in the study area

4.4.1 Contribution of agroforestry to food

Sources are as presented in Table 5 where different products (food) from Agroforestry, Agriculture and Market have contributed to food supply to the community. The quantities of food produced per year by Agroforestry, Agriculture and Market (bought) from different three villages Hembeti, Mkindo and Dihombo. Are as 181 565Kg while food supply from Agriculture was 279 000kg and food bought from market was 30 000kg. Also further statistical analysis was used to test on the contributions of the various sources to food if are statistically different, ANOVA table as Appendix 5. Since ($p < 0.05$) the Agroforestry and Agriculture are significant in food contribution.

Table 5: **Contribution of various sources to food sources**

	Products	Hembeti (kg)/ year	Mkindo (kg)	Dihombo (kg))/ year	Total (kg))/ year	Total (kg)/ year
Agroforestry	Banana (Bund= 40kg)	1440	1680	1200	4320	
	Cassava (Bag=70kg)	10780	12530	14210	37520	
	Beans (Bag =100kg)	31000	40500	36500	108000	
	Pigeon pea (Bag =100kg)	9800	11200	10500	31500	
	Fish (Kg)	85	77	63	225	181565
Agriculture	Paddy (Bag =100kg)	80300	72500	90200	243000	
	Maize (Bag =100kg)	16600	9400	10000	36000	279000
Buying from market	Maize (Bag =100kg)	9500	10100	10400	30000	30000

4.4.2 Contribution of agroforestry to income

Results in (Table 6) show the contributions from Agriculture, Agroforestry, Business and Employments as the sources of income to the people from three villages which are Hembeti, Mkindo and Didombo. Agriculture Tsh 108 000 000. Agroforestry Tsh 85 717 000, Tsh 1 380 000 Employments and Tsh 546 000 Tsh Business. Agriculture and Agroforestry are the main contributor to income generation of the studied villages. Other sources of income have varying but limited contributions to income generation of the local community.

Also further statistical analysis was used to test on the different contributions of the various sources to income of the people in the study area if are statistically different, ANOVA table as Appendix 6. Since ($p < 0.05$) the Agroforestry, Agriculture, Employments and Business are significant differ in income contributions to people.

Table 6: Sources of Income generation and their contributions to the local community

Villages	Agroforesrty (Tsh)	Agriculture (Tsh)	Employment (Tsh)	Business (Tsh)
Hembeti	28 572 333	36 000 000	460 000	153 000
Mkindo	27 511 547	34 502 300	320 000	211 000
Dihombo	29 633 120	37 497 700	600 000	182 000
Total	**85 717 000**	**108 000 000**	**1 380 000**	**546 000**

4.4.3 Contribution of agroforestry systems to wood energy in Mvomero district

The average of wood energy from Agroforestry and Natural forestry from the three villages was as, Charcoal and Fire wood from Agroforestry were 40%, 60% while wood energy contributions from natural forestry are fire wood are 43.3% Charcoal and 56.4% fire wood. Also further statistical analysis was used to test on the contributions of the various sources in to wood energy. ANOVA table as Appendix 7 and 8, since ($p > 0.05$) there is no significant differences in contribution or using of charcoal and fire wood from Agroforestry. Also since ($p > 0.05$) there is no significant differences in contribution or uses of charcoal and fire wood from the Natural forestry and Agroforestry.

Table 7: **Sources of wood energy and their contributions to local community**

Villages		Agroforesrty			Natural forest		
Hembeti		**Quantity/ year**	**Frequency**	**%**	**Quantit y/year**	**Frequency**	**%**
	Charcoal (Bag)	12	13	43.3	8	12	40
	Firewood (Bundle)	52	17	56.7	51	18	60
Total			**30**	**100**		**30**	**100**
Mkindo					10	13	43.3
	Charcoal (Bag)	10	14	46.7			
	Firewood (Bundle)	56	16	53.3	50	17	56.7
Total			**30**	**100**		**30**	**100**
Dihombo					9	14	46.7
	Charcoal (Bag)	18	9	30			
	Firewood (Bundle)	45	21	70	48	16	53.3
Total			**30**	**100**		**30**	**100**

4.3.4 Factors that influence Agroforestry adoption and mechanisms that would enhance it

The study found that there are several factors that influence Agroforestry adoption by the people in the study area. Results on Table 8 show factors enhancing the adoption of AFs and technologies in the study area as 26.7% Availability of Extension cervices, 22.2%, Land holding by people, 20% Education level of residents, 16.7% Technology characteristics and 14.4% Farmers income.

Table 8: **Factors that enhance agroforestry adoption by the local communities in Mvomero District**

Factors enhancing	**Frequency**	**Percent**
Land holding by residents	20	22.2
Education level of residents	18	20
Farmers income	13	14.4
Technology characteristics	15	16.7
Availability of extension cervices	24	26.7
Total	**90**	**100**

4.3.5 Factors that limit adoption of agroforestry by the local communities in Mvomero district

Respondents revealed several challenges (factors limiting the adoption of Agroforestry systems and technologies) they experience in practicing Agroforestry. Results on Table 9 show, which include Lack of Agroforestry knowledge by 24.7%, Land shortage 23.6%, Lack of quality tree species seeds 20.3% and Shortage of institutions supports on Agroforestry 31.4%.

Table 9: Factors that limit agroforestry adoption by the local communities in Mvomero District

	Frequency	Percent
Lack of Agroforestry knowledge	23	24.7
Land shortage	21	23.6
Shortage of quality tree species seeds	18	20.3
Shortage of institutions supports	28	31.4
Total	**90**	**100**

4.4 Discussion

4.4.1 Socio-economic characteristics of the respondents in Mvomero district

The finding of this study (Table 1) shows that most of the respondents (53.3%) had primary education. These findings were similar to those observed in Moshi Rural, Kilimanjaro Region where the highest number of the respondents (67%) had primary education (Mbwiga, 2016). Similar findings were also observed by Kushoka (2011) in Mvomero District where, the highest number of respondents (55%) had primary education. According to Kitalyi *et al.* (2013) for many years' maize, paddy and banana have been sustaining the livelihoods of farmers in Eastern Tanzania hence farmers afford to take their children to school, making Morogoro Region one of the well-educated regions. The majority of the respondents (79%) were farmers in Mvomero District. In support to this (URT, 2000) stated about (85%) of the population in Morogoro Region are thought to be involved in agriculture on a full time basis. Very few depend on other occupations as Employment, Business and Others (Carpentry, Tailoring or Masonry) are depended by only 2%. These lower involvements in other occupations is explained by O'Keefe (2007) who stated that, households' reliance on natural capital is greater in in many parts of Tanzania because off-farm diversification options are not much available hence farmers rely much on their AF homegardens for their livelihoods.

The findings on sex of respondents' male (67.8%) and female (32.2%), shows the male as the managers of the Agroforestry homegardens which are in contrast to findings of WinklerPrins and DeSouza (2010) that, in Brazil 78% of the Agroforestry homegardens listed were managed by women. In the present study most of the households (51.1%) had family sizes of 1-4 members followed by (43.3%) of family sizes of 5-8 members and the least (5.6%) made by family sizes of 9-12 members. These findings are contradicting those of Zaman *et al.* (2010) that in Bangladesh 60% of homegardeners households were medium sized family of 5-10 members. The highest number of respondents (51.1%) was of the age ranging from 46 years and above. According to Mbwiga (2016) the age group consisted of adults who returned home after retirement from employment or casual labour in the urban areas. At this age, mature adults tend to settle at home and take care of their AF homegardens as preparation of their security at old age (Mbwiga, 2016). Very few (6%) of household heads age was less than 35 years old. Contrary to these findings it has been observed in the Eastern Cape, South Africa, that Agroforestry homegardens were managed by households with the age group ranging from 31-45 years (Mbwigai, 2016).

Land size in the study area ranges from 0.25 to 2 ha of which the majority (57.8%) of the respondents fall in the land size of 0.25-0.50ha. This was because most of the people live on inherited land, the average size of an inherited plot being 0.56 ha (Soini, 2003). This outcome was consistent with the general features of Agroforestry homegardens as being of small plots near the family dwellings (Mitchell and Hanstad, 2004). The results are larger than those observed in Vietnam homegardens sizes which were ranging from 0.015-0.5 ha (Mbwiga, 2016).

4.4.2 Agroforestry practices adoption by the local communities in the study area

The results for the extent of Agroforestry adoption by the local communities of Mvomero district are presented in table 2 and (Appendix 4 ANOVA table). The adoption rate between villages are not differ, since because of the villages are located on the same geographical location, all sampled villages have connected are not much far away from the Mvomero District headquarter office where Agriculture office, Natural resource office, livestock offices and Forest office are found which increases the availability of Extension cervices to all nearby villages. All villages consist of most permanent residents who possess certain land size, also they have at list Primary education and above (Table 1) which helps in the adoption process for Agroforestry practices.

The findings of the study area on high Agroforestry adoption by the local communities are similar to the findings reported by (Chija, 2013) in Kasulu, where the farmer communities were reported to depend on Agroforestry as their main source of food and income. The indication of higher adoption of Agrosilvicultural system (Table 2) could be attributed to the fact that Agricultural crop production is the major socio-economic activity of the local communities in the district (URT, 2014; Mvomero District Investment Profile, 2017). Results from this study are similar with the results reported for Mufindi, Iringa Tanzania (Mgeni, 2008), Mandi District, Western Himalayas, India (Sood, 2006).

4.4.3 Agroforestry systems and technologies in use in the study area

4.4.3.1 Agroforestry systems in the study area

In this study (Table 3), three types of Agroforestry systems practiced in the study area, namely as Agrosilviculture, Aposilviculture and Aquosilviculture were used. The Agrosilviculture system was the most system used system than any other system in

the District followed by Aposilviculture and Aquosilviculture. These Agroforestry systems were practiced because of the presence of the support conditions such as people had possess some amount of land which allow them to install some long term small scale production projects such as interactions of herbaceous crops with wood perennials. Availability of natural resources such as availability of wet land which facilitate production of fish, also mostly of the residents has at list primary level education (Table 1) which helps in understanding of Extension education provided by the extension agents , the similar concept was explained by (Rojas *et al.*, 2020) who show issues essential for adoption such as age and education as human capital variables, which are individual farmer characteristics inherited or acquired that influence or motivate the decision to adopt and education was one among those factors.

The reason of Agrosilviculture system to be practiced mostly was due to the community to depend on the Agricultural crops for food and income. The reason for mostly practicing Agrosilviculture system was due to Agricultural crops production was the major social-economic activity of the local communities in Tanzania. Also the findings are supported by (Chija, 2013) show that the adoption status of Agroforestry in Kasulu District was 91% of the three Agroforestry systems namely Agrosilviculture, Agrosilvopasture and Silvopasture are currently in use in the district with the Agrosilvicultural system (42%) being the most adopted system. Also these findings suppored by Sebukyu and Mosango (2012) reported that farmers adopted five types of Agroforestry systems, namely: Agrosilvipasture (45.5%), Agrosilviculture (32.9%), Silvopasture (16%), Aposilviculture (4.5%) and Agroaguosilviculture (1.1%) in Masaka District Uganda.

4.4.3.2 Agroforestry technologies in the study area

The survey data (Table 4) revealed that the arrangement of components which led to the classification of the most practiced Agroforestry technologies in an area. Amoung Agroforestry technologies practiced the alley farming by (45.5%) was the leading Agroforestry technology practiced among other Agroforestry technologies practiced to an area. These findings are supported by (Faith, 2015) that most of farmers have adopted woodlots, boundary tree planting, home garden, alley cropping and hedge planting. Benefits from practicing such practices were mentioned to range from fodder, fruits, food, timber, building poles as well as soil fertility improvement and income that is obtained from selling of the products obtained from agroforestry. Also these findings supported by (Elizabeth *et al.,* 2010) who show that 56.3% of those adopting alley farming in Southwestern Nigeria used alley trees as fodder for their livestock, 7.1% used the trees for maintaining soil fertility, and 36.3% used them for both forage and maintenance of soil fertility. Also this is in agreement with the results of Galhen *et al*. (2013) study which found Agroforestry homegardens to be delimited by the physical demarcations such as boundary planting, These Agroforestry technologies are employed by farmers to mark their AF Home gardens boundaries also a way that allows farmers to use the middle space more effectively (Mbwiga, 2016).

4.4.3.3 Contribution of agroforestry to the livelihoods (food, income and wood energy supply) of the local communities in the study area

Agroforestry is among the important sector in Tanzania contributing to livelihood of many local communities. To understand the contribution of Agroforestry to the livelihood of local communities in Mvomero district, a question was posed to local people on what is the contribution of Agroforestry activities on their livelihoods. The findings were as the major sources of income were Agriculture, Agroforestry, Employments and Business

Table 5. Those sources of income are differing in contributions as Agriculture 279 000kg, Agroforestry 181 565kg and Market (buying) 30 000kg. Agriculture was the major contributor to the food of the people in the study area, followed by Agroforestry then Employments and finally Market (buying). When they were asked to give reasons, they mentioned that, both Agriculture and Agroforestry provide food for the household, increase income and help to get basic needs and wood energy supply. Those findings are supported by (Karki, 2018), explain as in developing countries, Agriculture sector plays an important role for their national. The Agricultural sector is important for most developing countries including Kenya, India and Tanzania because of its contribution to national economy and food security through overall domestic production, trade and employment. In Tanzania, Agriculture provided 85% of the export earnings, contributed to 25% of its GDP and employed about 65% of the work force. Economy and food security, including domestic production, trade and employment. Agriculture has huge importance to alleviate poverty compared to other sectors such as industry and services especially in developing countries. Therefore, increasing the efficiency of Agricultural production improves household food and nutrition security and income of smallholders and thus helps to reduce poverty.

Some of the respondents (33%) reported that an increased yield of food crops from a mixed tree and crop farm. Agroforestry contribute in supports of households' socio-economic activities such as school fees, health service cost; increase income per capita and help to get basic needs. In other areas Agroforestry has been observed that there is a potential contribution of Agroforestry to food security, for example in Katsina, Sudan Savannah Area, Nigeria (Abdulhamid *et al.*, 2017).

The reason on difference in food sources to an area was due to difference in introduction and adoption between Agriculture with best Agronomic practices and Agroforestry to an area, Agriculture (Agronomic practices) was introduced and adopted and so practiced traditionally before the Agroforestry practices which makes differ in practicing among Agroforestry and Agriculture. Also there are people who are not farmers such as Employees. Business man Table 1, always they buy food from the market.

4.4.3.5 Sources of income generation and their contributions to the local community

The main sources of income at the study area were Agriculture, Agroforestry, Employments and Business. But those income sources differs in income contributions to the local people as in Table 6, Agriculture 108 000 000 Tsh was the main major source of income contribution to the people in the study area followed by Agroforestry by 85 717 000 Tsh contribution, and finally followed by Employment 1 380 000 Tsh and Business 546 000 Tsh. These results are supported by (Osei, 2011) show that, in Ghana, Agriculture continues to be one of the dominant sectors of the economy, in terms of its contributions to output, employment, revenue generation, and foreign exchange earnings. Also studies conducted by Kabwe *et al.* (2016) in Zambia, Maduka (2007) in Lushoto District, found that, Agroforestry complement the communities' livelihood and revealed that society is supporting Agroforestry as has been identified as an alternative to the decline of livestock keeping economy.

Also the sources of income differ in contribution due to difference in occupations among community such as farmers employments and business at the study area Table 1. Which then affects the income of the people, also Agroforestry and Agriculture differs in income contributions to the local people in the study area due to differences in practices

that leads to effects in production and finally in income generation caused by adoption differences between Agroforestry and Agriculture.

4.4.4 Factors that influence agroforestry adoption and mechanisms for scaling up in the study area

The present study identifies the different mechanisms for improving the Agroforestry adoption and giving solution on the challenges which affects the adoption of Agroforestry practices in the study area. The study found that factors that influencing in adoption of Agroforestry practices are as, 26.7% Availability of Extension cervices. This increases the adoption of the Agroforestry practices to the farmers as well as acquired increasing of extension cervices also the adoption or Agroforestry practices increases, this can be seen by (Mwase *et al.,* 2015) The study revealed that the major factors affecting adoption of Agroforestry fall into two main categories of socioeconomic and biophysical factors. The factors are high initial costs of Agroforestry practices (75%), low extension knowledge (69%); unavailability of Agroforestry germplasm (69%) for economic, social and biophysical categories respectively. The study findings by (Zerihun, 2020) explain about Agroforestry practices are land-based economic development strategies with a perceived positive role in supporting rural livelihoods. The study finds that the larger number of extension services, access to credit, access to extension, information exchange among farmers, trust in local institutions, active participation in social groups and organizations, and prior exposure to Agricultural technologies are the variables that positively affect the adoption of Agroforestry innovations in the study area.

The study found 22.2% Land holding by people affects the adoption of the Agroforestry practices, This can be supported by the study of (Mugure *et al.,* 2013) explain on the an

outcome of a descriptive survey study that was conducted in Nambale division, Busia County in Kenya, which partly examined the factors influencing adoption of Agroforestry practices among rural households. The adoption of Aroforestry has not been very successful due to land ownership and land rights aspects that have adversely affected its adoption to the larger extent. In Kenya, land ownership remains exceedingly skewed in many rural parts of the country. The authors argue that when land ownership is extremely unequal, agroforestry activities and its growth delivers fewer paybacks for the poor rural households.

Education level 20% of residents, Education is very important in adoption of the Agroforestry practices, education simplify the understandings of the people about innovations, this can be supported by (Riddell, 2012), explain on Adoption of innovations by firms and workers is an important part of the process of technological change. Many prior studies find that highly educated workers tend to adopt new technologies faster than those with less education. Such positive correlations between the level of education and the rate of technology adoption, however, do not necessarily reflect the true causal effect of education on technology adoption. Formal education increases the use of technologies that require or enable workers to carry out higher order tasks, but not those that routinize workplace tasks. Also study by (Chang and Nam, 2021) show the differences in the level of education have been validated in some studies. It is generally known that people with higher education tend to pay more attention to the usefulness and benefits of innovative technologies, also explained on differences between groups with high education levels and those with low education levels in their expectations and adoption of smart home devices.

Farmer's income 16.7 %, the study supported by (Sharma and Kumar, 2000) the farmers with higher income and social status is more likely to adopt agro-forestry than those with low income and social status. It is also expected that the farmers with sources of off-farm income in addition to their farm income are less risk averse and the farmers without sources of off-farm income tended to be more risk averse. Risk aversion is expected to be associated positively with the increase in age and negatively with higher levels of education (Chija, 2013) reported that, income is a proxy for wealth status. Farmer's income is positively related to adoption of Agroforestry systems and technologies implying that the rich farmers adopt AFs and technologies more than the poor farmers. This could be caused by the power the individual has to purchase new inputs such as improved seeds, fertilizes etc. and or implements and extend facilities for improved and higher productivity which is dictated by individual financial capability.

Technology characteristics 16.7% of Agroforestry technologies are known to be more sophisticated than those of annual crops practices because of the multi-components, multi-ages testing and management nature (Chija, 2013). Adoption occurs when one has decided to make full use of the new technology as a best course of action for addressing a need. Adoption is determined by several factors including socioeconomic, environmental, and mental processes that are governed by a set of intervening variables such as individual needs, knowledge about the technology and individual perceptions about methods used to achieve those needs (Kabwe *et al.,* 2009). Results by (Magugu *et al.,* 2018) revealed that farmers with bigger farms and higher education were more likely to adopt the new technology. Additionally, farmers were quicker to adopt technology if they had an increase in crop yields and had stayed longer in the study area. The results suggest that, adoption would be more enhanced with a clear focus on extension activities, income enhancing Agroforestry practices and soil amelioration technologies.

4.4.5 Factors that limit agroforestry adoption by the local communities in Mvomero district

Shortage of institutions supports on Agroforestry 31.4%. Government and some NGO such as SAT (Sustainable Agriculture Tanzania) provide support on the dissemination of the Agroforestry practices to the farmers but Agroforestry support provided only in some of Districts in Tanzania while other District do not receive any support on Agroforestry (Kitalyi *et al*., 2010).

Lack of Agroforestry knowledge 24.7%, the study by (Tokede *et al.,* 2020) support that, farmers' knowledge and attitudes towards the adoption of Agroforestry. The demographic factors analyzed showed that the majority of respondents were (66%) do not practice Agroforestry and possessed low knowledge of Agroforestry practices. Respondents' attitudes towards the practice were inadequate. Furthermore, knowledge of Agroforestry was found to influence the willingness to adopt the practice, attitudes towards agroforestry practice also influence its adoption in the study area. Based on the findings, this study recommends that extension agents and other stakeholders should intensify effort to pass down adequate knowledge on the practice and advantages of Agroforestry to farmers in the simplest form it can be well understood, to improve their attitudes and increase their rate of adoption of agroforestry practices.

Smallholder farmers are the major recipients of Agroforestry technologies, but unfortunately few farmers and other stakeholders involved in agriculture and natural resources management have been exposed to Agroforestry technologies (Chija, 2013) explain that, with high level of awareness of Agroforestry systems, there was likely to be high adoption, since farmers were aware of a given system adoption.

Shortage of quality tree species seeds 20.3%.Study supported by (Mwase *et al.,* 2015) explain on the Inadequate availability of seed and seedlings is one of the barriers to adoption of agroforestry. Agroforestry seed planted by rural communities is mostly procured through local farmer collection and nongovernmental organizations.

Also (Chija, 2013) explain on that insufficient amounts of good quality seeds, constrained the widespread uptake of improved fallows. One of the greatest constraints of some Agroforestry technologies was lack of access to quality seeds in Lusaka, Zambia. Unlike the seeds of annual crops in which established institutions exist to promote them and also private sector organizations have been engaged in their multiplication and distribution, there is little or no institutional structure to make the seeds of Agroforestry tree species available. Study by (Kiyani *et al.,* 2017) explains that, due to lack of skills and technical know-how, capital and quality seeds, some farmers are declining to adopt the new Agroforestry practices. Through providing subsidies to farmers, regular training, and informal education, establishing tree nurseries to improve the production of quality seeds, and also involving farmers in decision-making will increase Agroforestry adoption. The government and other stakeholders should consider the views expressed by the farmers and take the necessary steps to address these challenges facing agroforestry technology adoption.

Land shortage 23.6% this study is supported by (Mugure 2013) explain on the adoption of Agroforestry has not been very successful due to land ownership and land rights aspects that have adversely affected its adoption to the larger extent. In Kenya, land ownership remains exceedingly skewed in many rural parts of the country. The authors argue that when land ownership is extremely unequal, Agroforestry activities and its growth delivers fewer paybacks for the poor rural households. Land tenure problems have been

exacerbated by continuous fragmentation of land, land inheritance, gender imbalance in land ownership and the rights to land use. The paper concludes that the decision to adopt Agroforestry was partly influenced by land and tree tenure, size of land and gender equity (women's rights to property and recognition of co-ownership). Additionally, rural households' investments in Agroforestry increase with increasing in land tenure. The important policy recommendation made is that laws affecting adoption of Agroforestry practices should be updated and harmonized in-order to achieve the 10% tree cover and for farmers and households to achieve the maximum benefits of Agroforestry. Also (Arun and Kumar, 2020) findings show that area of farmland was found as the major constraint to Agroforestry adoption for smallholder farmers. Some other variables that affected positively included livestock herd size, provision of extension service, home-to- forest distance, farmers' group membership and awareness of farmers about environmental benefits of agroforestry. Irrigation was another adoption constraint that the study area farmers were faced with. The households with a means of transport and with a larger family (household) size were found to be reluctant regarding agroforestry adoption. A collective farming practice could be a strategy to engage the smallholder farmers in agroforestry.

It has long been recognized that conservation practices such as terraces and contour strips as well as Agroforestry practices reduced land from crop production. From farmer's perspective, reduction in land area for growing crops may be seen as a sacrifice. It implies that farmers with small plots of land cannot afford to take land out of food production and put it under conservations purposes (Chija, 2013).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the findings obtained and the proceeding discussion the following

Conclusions have been drawn:

Currently the adoption status of Agroforestry practices by the communities in Mvomero was high due to availability of the some extension cervices concern Agroforestry and Agriculture from Government and Non-Government Organizations, More efforts are needed so as to maintain and improve the Agroforestry practices adoption to the rural people.

Even though Agroforestry is practiced, but Practices based on the few Agroforestry systems and technologies while there are many Agroforestry systems and technologies that can be practiced and provide many economic benefits to environments and people and reduces people to depends on some few resources as life support.

Government and Non-Government Organizations should provide Agroforestry inputs supports such as Provision of the tree seedlings for trees and herbaceous crops interaction to rural people as a way of improving the Agroforestry adoption.

5.2 Recommendation

i. Agroforestry systems and their respective technologies that are mostly Preferred by the communities should be emphasized and farmers be advised to diversify Agroforestry components to provide a range of products and services so as to increase their ability of sustaining food supply and income generation to the entire community.

ii. Training of both Agricultural extension officers and farmers is needed so as to solve the problem of Agroforestry knowledge. Land shortage can be solved by Agroforestry intensification.

iii. Shortage of input can be solved by the Government through sensitizing farmers groups and provide loans them inputs such as tree seeds and seedlings to farmer groups, but also educate farmers to have their own tree nurseries such that the seedlings can be accessed easily by farmers.

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APPENDICES

Appendix 1: Household questionnaires assessments of the status of the Agroforestry practices

A. General information

1. Name of interviewer/Household head……..
2. Date of interview……
3. District name……..
4. Name of Division……..
5. Name of Village……
6. Sex of the respondent: (i) Male [ ] (ii) Female [ ]
7. What is your age……
8. What is your household size...?
9. What is the size of your landholding (in ha)……..
10. Do you face problems of pests and diseases in your farm? (i) Yes [ ](ii)No[ ]

B: Status of agroforestry practices/adoption

1. Do you plant wood perennial (s) in your farmland? (i) Yes [ ] (ii) No [ ]
2. Who is involved in tree planting (agroforestry)? (i) Man only [ ] (ii) Woman only (iii) Both man and woman [ ] (iv)Others (specify) …….
3. What was the main reason (s) for adopting or not adopting Agroforestry? ....
4. What type of Agroforestry systems do you practice on your farm?

   Agrosilviculture……Silvopasture……..Agrosilvopasture…

   Aposilviculture……. Aquosilviculture……Others (specify)……...

5. What are the benefits of practicing such systems?

   i……ii…….iii……

6. Do you need to continue with such systems? Yes [ ] No [ ]

7. a) If Yes why? Please give reason(s)

   i……...ii……..iii……

   b) If No, why and what is your suggestions?

   i……..ii…….iii……

8. What are the major challenges do you encounter from practicing such system?

   i……..ii…….iii……

9. From the major challenges/problems you mentioned above what are your suggestions or what should be done to encounter such challenges/problems?

   i……..ii…….iii……

10. What type of Agroforestry technology/ies do you practice?

    Alley farming…….Hedgerow intercropping…….Home gardens……, Boundary planting, …….Taungya……

    Other (specify)……

11. What are benefits of such Agroforestry technology/ies in your farm?

    i……..ii…….iii……

12. What are the major challenges/problems do you encounter from practicing such technologies?

    i……..ii…….iii……

13. From the major challenges/problems you mention above what are your suggestions or what should be done to encounter such challenges/problems?

14. Do you grow any herbaceous crops in your farm? (i) Yes [ ] No [ ]

15. If yes, which herbaceous crops are found in your farm and their uses?

S/N	Specie type/common name/scientific name	Reason for integrating tree (s)
1		
2		
3		
4		

16. Do you keep any animals? (i) Yes [ ] (ii) No [ ]

17. If yes what animal (s) do you have in your farm land?

S/N	Specie type/common name/scientific name	Reason for integrating tree (s)
1		
2		
3		
4		

18. Do you keep any insects? (i) Yes [ ] (ii) No [ ]

19. If yes what insect(s) do you have in your farm land?

S/N	Specie type/common name/scientific name	Reason for integrating tree (s)
1		
2		
3		
4		

20. Do you keep any aquatic life form living organism?

(i) Yes [ ] (ii) No [ ]

21. If yes what aquatic life form do you have in your farm land? .....

.....

22. Do you think you need more training, access to extension officers, services and material support from the Government to adopt and have more Agroforestry practices? (i) Yes [ ] (ii) No [ ] Why? Give reasons……..……

23. Which component (s) do you mostly prefer and why?

i……..ii…….iii……

D: Contribution of Agroforestry to the livelihoods (food, income and wood energy) of the local communities

1. What is/are the main source(s) of food for your household?

   (i) Agriculture…… (ii) Agroforestry…….(iii) Livestock……..
   (iv) Purchase…….(v) Other (Specify)……

2. What is/are the main source(s) of income for your household?

   (ii) Agriculture…… (ii) Agroforestry…….(iii) Livestock……..
   (iv) Business…….(v) Other (Specify)……

3. What is/are the main source (s) of wood energy supply for your household?

   (i) Natural forest (ii) General land forest [ ] (iii)Agroforestry [ ]

   (ii) (iv)Woodlots [ ] (v) Other (Specify) ……

4. How much Agroforestry practices contributes to your

   (i) Food supply (Bags/year)……

   (ii) Income generation (TZS/year)……..

   (iii) Wood energy (Bundles/year)……

E: Factors that influence agroforestry adoption and mechanisms of its scaling up

1. What enhance you to practice Agroforestry?

   i……..ii…….iii……

2. What challenges do you experience in practicing Agroforestry?

   i……..ii…….iii……

3. What limit you from practicing Agroforestry?

   i……..ii…….iii……

4. What measures required for improving Agroforestry practices?

   i……..ii…….iii……

5. What is your comment on the practice of Agroforestry?

i……..ii…….iii……

Appendix 2: Checklist for the district forest officer

1. Name of DFO……
2. How many households practice Agroforestry in the district…….
3. Is there any training/education provided on practice of Agroforestry?

   (i) Yes [ ] (ii) No [ ]
4. If no why and what should be done……
5. Do you provide seeds/seedlings to the local people? (i) Yes [ ](ii) No [ ]
6. If yes what tree species do you provide?
7. What tree species do they prefer most, and why do you think they prefer them……
8. What are the main/common Agroforestry components in this district?

   i……..ii…….iii……
9. What are the main/common Agroforestry systems in this district?

   i……..ii…….iii……
10. What are the main/common Agroforestry technology/ies in this district?

    i……..ii…….iii……
11. What are the main/common sources of food in this district?

    i……..ii…….iii……
12. What are the main/common sources of income generation activity in this district?

    i……..ii…….iii……
13. What is the main/common wood energy in this district?

    i……..ii…….iii……

14. How much Agroforestry practices contributes to:

    (i) Food supply (Bags/year)……

    (ii) Income generation (TZS/year)……..

    (iii) Wood energy (Bundles/year)

    ……

15. What are the factors enhance Agroforestry practices in the district?

    i……..ii…….iii……

16. What are the factors limit Agroforestry practices in the district?

    i……..ii…….iii……

17. What measure required improving Agroforestry practices in the district?

    i……..ii…….iii……

Appendix 3: Checklist for extension officer and village executive officer

1. Name of extension officer/VEO……...
2. How many households practice Agroforestry in this village? .....
3. Is there any training/education provided on practice of Agroforestry?

   (i) Yes [ ] (ii) No [ ]
4. If no why and what should be done……
5. Do you provide seeds/seedlings to the local people? (i) Yes [ ](ii) No [ ]
6. If yes what tree species do you provide?
7. What tree species do they prefer most, and why do you think they prefer them……
8. What are the main/common Agroforestry components in this village?

   i……..ii…….iii……
9. What are the main/common Agroforestry systems in this village?

   i……..ii…….iii……
10. What are the main/common Agroforestry technology/ies in this village?

    i……..ii…….iii……
11. What are the main/common source of food in this village?

    i……..ii…….iii……
12. What are the main/common sources of income generation in this village?

    i……..ii…….iii……
13. What are the main/common sources of wood energy in this village?

    i……..ii…….iii……
14. How much Agroforestry practices contributes to:

    (iv) Food supply (Bags/year)……

    (v) Income generation (TZS/year)……..

    (vi) Wood energy (Bundles/year)……

15. What are the factors enhance Agroforestry practices in this village?

    i……..ii…….iii……

16. What are the factors limit Agroforestry practices in this village?

    i……..ii…….iii……

17. What measure required improving Agroforestry practices in this village?

    i……..ii…….iii……

Thank you very much for your cooperation!

Appendix 4: ANOVA table for extent of adoption of agroforestry systems and technologies in Mvomero District

Source of variations	Df	SS	MSS	F-value	P –value
Rows	2	0.288889	0.144444	1.16	0.3183
Columns	87	10.8333	0.124521		
Total	89	11.1222	0.4138		

Appendix 5: ANOVA table for contribution of various sources to food sources in Mvomero District

Source of variations	Df	SS	MSS	F-value	P –value
Between Groups	7	23.003	3.286	7.284	0
Within Groups	82	36.997	0.451		
Total	89	60			

Appendix 6: **ANOVA table for sources of Income generation and their contributions to the local community**

Source of variations	Df	SS	MSS	F-value	P –value
Between Groups	3	45	15	86	0
Within Groups	86	15	0.174		
Total	89	60			

Appendix 6: ANOVA table for sources of wood energy (charcoal and fire wood) from Agroforestry to the local community

Source of variations	Df	SS	MSS	F-value	P – value
Between Groups	1	0.046	0.046	0.067	0.796
Within Groups	88	59.954	0.0681		
Total	89	60			

Appendix 7: **ANOVA table for sources of wood energy (charcoal and fire wood) from Natural forestry to the local community**

Source of variations	Df	SS	MSS	F-value	P – value
Between Groups	1	0.045	0.045	0.066	0.798
Within Groups	88	59.955	0.0681		
Total	89	60			