# TECHNICAL EFFICIENCY IN AGRICULTURE AND ITS IMPLICATION ON FOREST CONSERVATION IN TANZANIA

## The Case Study of Kilosa District (Morogoro)

**Samwel Lwiza**

**M.A. (Economics) Dissertation**

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# CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Dar es Salaam this dissertation entitled, '***Technical Efficiency in Agriculture and its Implication on Forest Conservation; The Case study of Kilosa District (Morogoro)***', in partial fulfilment of the requirements for the award of a degree of Master of Arts (Economics) of the University of Dar es Salaam.

Signature …………………………………..

Dr.Razack B. Lokina
(Supervisor)

Date……………………………

## DECLARATION

## AND

## COPYRIGHT

I, **Samwel Lwiza**, declare that this dissertation is my original work and it has never been presented and will not be presented to any other university for a similar or any other degree award.

Signature…………………………………………….

## ACKNOWLEDGEMENTS

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However, despite their contributions I am entirely responsible for any shortfall in this dissertation.

## DEDICATION

To my family, Mr and Mrs Felix Lwiza

And

My loving mother Mrs Oliver K. Lwiza.

## ABSTRACT

Majority of the households living adjacent to the forest depend primarily on agriculture and secondarily on forest resources. For these households, agriculture plays a key role, for subsistence needs and as the source of income, forest on the other hand is the major source of energy, building materials and income as well. Decrease in agriculture production lead the rural communities fail to fulfil their subsistence needs as well as incomes, thus exerting pressure on forest resources clearing and extraction. Improvement in technical efficiency in agriculture is one among the ways by which agricultural production can be increased; therefore reduces pressure on further land clearing and forest extraction.

This study examined the technical efficiency in farming activities and its implication on forest conservation in Kilosa District. The empirical analysis was based on the data collected from 301 households selected randomly from five villages in Kilosa district, in which three villages were under REDD project. Two empirical models were estimated in the study; stochastic frontier Translog production function and forest resources extraction model. The stochastic frontier Translog production function was estimated using FRONTIER 4.1 program, whereas Ordinary Least Square (OLS) method was used to estimate forest extraction model.

The empirical findings indicated that the mean technical efficiency of small scale farmers in Kilosa district was 64 percent, implies that farmers in Kilosa District still have the room to improve their farming efficiency by 36 percent. In addition, farming technical efficiency among the households indicated to be influenced by the level of farming inputs usage, gender and educational level of the household head, extension services, farm experience and access to formal credits.

Furthermore the study indicated that, technical efficiency, sex and distance of the village from the forest are significantly negative related to extraction of forest resources, whereas, household size and primary education of the household head shown to be strongly positively related to forest extraction. Thus the study calls for policy intervention so as to improve farming efficiency and reduce deforestation and forest degradation.


**Key words**: REDD, Forest, Deforestation, Agriculture, Technical efficiency, stochastic frontier.

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| | |
|---|---|
| CBFM | Community Based Forest Management |
| EAMCEF | Eastern Arc Mountains Conservation Endowment Fund |
| FAO | Food and Agriculture Organisation |
| JFM | Joint Forest Management |
| LAFR | Local Authority Forest Reserves |
| LEAD | Leadership for Environment and Development |
| LEAT | Lawyer’s Environment Action Team |
| MAFC | Ministry of Agriculture Food Security and Cooperatives |
| MNRT | Ministry of Natural Resources and Tourism |
| NBS | National Bureau of Statistics |
| NFP | National Forest Policy |
| NSCA | National Survey Census of Agriculture |
| PFM | Participatory Forest Management |
| REDD | Reduced Emission from Deforestation and Forest Degradation |
| TFAP | Tanzania Forest Action Plan |
| TFCG | Tanzania Forest Conservation Group |
| TFWG | Tanzania Forest Working Group |
| TIC | Tanzania Investment Centre |
| UN-REDD | United Nations- REDD |
| URT | United Republic of Tanzania |
| VLFR | Village Land Forest Reserves |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Tanzania has a total land area of 94.5 million hectares of which, the total forest area is estimated at 35.2 million hectares, which is equivalent to 39.9 percent of the country landmass (URT, 2012; UN-REDD, 2013). The country has various forest types include woodlands, montane, mangrove, acacia forests and coastal woodlands. In addition, the forest categories are based on five ecological regions; Eastern Arc, Mountains in the east, The Albertine Rift in the west, volcanic mountains in the north, Miombo woodlands in semi arid areas and Acacia commiphora in the most arid regions (Chamshama and Vyamana, 2010).

Based on management and ownership, forest resources in Tanzania is classified as; the forest area that has been gazetted as forest reserves and protected areas, which is about 18 million hectares, equivalent to 43 percent (URT, 2012) and forest area under the Participatory Forest Management (PFM) which constitute up to 3.67 million hectares, equivalent to 10.8 percent. PFM is divided into forest management under Joint Forest Management (JFM) arrangement on Government owned forest reserves, and Community based Forest Management (CBFM) on Village Land Forest Reserves (VLFR) (Blomley and Iddi, 2009). Over 150,000 hectares of gazetted area is under plantation forestry and about 1.6 million hectares are under water catchment management (URT, 2012).

The contribution of the forest sector to Tanzanian economy are estimated to be around USD 2.2 million, or 20.1 percent of the GDP based on 2006 prices (MNRT, 2008). The sector also provides employment to an estimated 3 million people to the Government administration and other forest related activities and industry (MNRT, 2008; Blomley and Iddi, 2009).

Forestry in Tanzania is guided by a number of policies and legal frameworks that ensure sound, effective and sustainable management of the forest resources as well as supporting the development and poverty reduction objectives. This include the National Environmental policy of 1997 and forest policy of 1998, these enhance the contribution of the forest sector to the sustainable development of Tanzania for present and future generation (URT, 1998). In addition, they provide foundation for PFM and seek to integrate biodiversity values in forest management (Blomley and Iddi, 2009). The Land policy of 1995, which provides the framework for the allocation of land tenure rights (URT, 2012). The National Energy Policy of 2003 which aims at reducing forest depletion from extraction of wood fuel and charcoal (UN-REDD, 2013).

Apart from forest policies, forest conservation supporting laws are enacted in Tanzania based on management of land and forest resources. The Land Act of 1999 and Village

Land Act of 1999, enable the allocation and securing of land tenure rights for communities (URT, 2012). The Forest Act of 2002, which recognizes and promotes sustainable forest management and utilization through participatory and community based forest management (LEAT, 2010; Blomley and Iddi, 2009; Blomley et al, 2008), and Environment Act of 2004, which recognizes the importance of forest for climate change mitigation and empowers the Minister for Environment to take action on climate change (LEAD, 2007; Richard et al, 2009).

It was reported that natural forests are disappearing at an estimated rate of between 130,000 and 500,000 hectares per year (FAO 2006). It is also estimated that, between 1990 and 2005, Tanzania lost 14.9 percent of its forest cover equivalent to 6,184,000 hectares. Likewise, between 2000 and 2010, the country lost about 10.8 percent of the total forest cover, equivalent to 1.1 percent per annum (Mwakaje et al 2010; FAO, 2010).

The main direct causes of deforestation and forest degradation in Tanzania are; land clearing for agriculture, overgrazing, wild fires, charcoal marking, persistent reliance on wood fuel for energy, over-exploitation of wood resources and lack of land use planning (Blomley and Iddi, 2009; Blomley et al, 2008).

Therefore the main focus of this study is to examine the technical efficiency in agricultural production and link it with the deforestation and forest degradation.

Generally, agricultural production affects condition of the forest resources especially in villages adjacent to the forest; Kilosa district is one among villages in Tanzania that located adjacent to the forest and practising farming activities as well. Moreover, as pointed by Luoga et al. (2000), one way to build capacity for managing natural resources is to improve farm productivity and help people to engage in alternative income generating activities. Therefore, investigating farming efficiency provides the basis for improving agricultural productivity, and thus reduces deforestation and forest degradation.

Agricultural sector on the other hand, play a major role in Tanzanian economy. It contributes about 24.1% of the GDP and employs about 70% of Tanzania population (NBS, 2010), and thus the country's GDP is sensitive to agriculture sector's performance especially crop production. The sector contributed between 13 and 20 percent to total merchandise export through traditional agriculture exports in the last 9 years (NBS, 2012).

Despite its importance, the sector's practice and performance in Tanzania is not so well, as it is dominated by small-holder farmers cultivating average farm size of between 0.9 to 3.0 hectares each (NBS, 2012), where 85 percent of farmers own less than 4 acres of land. In addition, more than 95 percent of Tanzanian's crop area is cultivated by hand hoe, 18 percent by ox-plough, less than 10 percent by tractor, whereas more than 96 percent depending on rainfall (MAFC, 2008).

Thus due to its practice, agricultural activity in Tanzania is among the factors which affect the forest condition through forest clearing for cultivation purpose. According to National Bureau of Statistics(NBS) 2003,the area under cultivation recorded in 2002 was 9.1 mil hectares, this area increased up to 10.2 mil hectares in 2008 (Sulle and Nelson (2009). The agricultural land increase between the two periods was about 12 percent (2% average annual increase, equivalent to 182,000 hectares).

The average annual agricultural growth since 1970 was recorded as 2.9 percent in 1970s, 2.1 percent (1980s), 3.6 percent (1990s) and 4.7 (2000s), (URT, 2006; NBS, 2010). This shows that agriculture has been growing at less than 5 percent annually in the past four decades. In addition, between 2002 and 2008, there was a similar trend between major cash crops production (cotton, coffee, tea, sisal, cashewnuts, sugar and tobacco) and the size of the area cultivated (MAFC, 2008).It indicates that, agricultural growth in Tanzania, as in many Sub-Saharan African (SSA) countries may largely be determined by area expansion and to a lesser extent by increased productivity (Nkonya et al, 2008; Lokina et al, 2011).

As the majority of rural communities depend heavily on agriculture and forest products for supporting their daily life, giving the ownership rights to the village communities and enforcement of the rules will only lead to displacement effects, whereby communities will extend their extractions efforts into none protected forest (Robinson and Lokina, 2011). Also, as pointed by Luoga et al. (2000) that, one way to build capacity for managing natural resources is to improve farm productivity and help people to engage in alternative income generating activities. Therefore, improving agricultural productivity, will to a much extent, enhance rural incomes and reduce forest dependency.

## 1.2 Problem Statement

Communities living adjacent to the forest depend mainly on agriculture and forest for subsistence and as a source of income, thus involve themselves in agriculture and forest extraction. Changes in forest laws and policies, supporting Participatory forest management (PFM) and providing forest conservation incentives are among the measures that have been undertaken by the Government, International agencies and Non-Governmental Organizations (NGO's) towards the effort to protect forests.

However, forest resources extraction is continually increasing, and the main cause is land clearing for expansion of agricultural activities in response to population growth, poverty and food shortage. It is recorded that, in 2002 the area under cultivation was 9.1 mil hectares with total crop production of Tshs 2 trillion (NBS, 2003), the area increased up to 10.2 mil hectares in 2008 (the increase of 12 percent between two periods and 2% average annual increase), with crop production of Tshs 2.7 trillion (NBS, 2010). In addition, the average annual agricultural growth since 1970 was recorded as 2.9 percent in 1970s, 2.1 percent (1980s), 3.6 percent (1990s) and 4.7 (2000s), (URT, 2006; NBS, 2010). Overall productivity in agricultural sector has been that significant for the last decades, the increase in output is largely attributed by expansion in farmland (Nkonya et al, 2008; Lokina et al, 2011).

Thus, the study is going to examine technical efficiency in agriculture for the farmers living adjacent to the forest and link these efficiencies with forest resources extraction.

## 1.3 Objectives

### 1.3.1 Main Objectives

The main objective of this study is to examine the technical efficiency in farming activities and its impacts on forest conservation by the communities adjacent to the forest margin.

### 1.3.2 Specific Objectives

i) To examine technical efficiency in agriculture by forest-adjacent communities.

ii) To explore social economic variables that affect farming technical efficiency

iii) To estimate social-economic factors influencing forest resources extraction.

## 1.4 Significance of the Study

The study is aiming at evaluating technical efficiency in agriculture for the famers living adjacent to the forest and how these efficiencies contribute to forest degradation.

The main significance of this study is for academic purposes as it might be used as reference point for the coming students who will be interested in conducting their research in this area.

Agricultural production below potential level reduces incomes and profits that can be generated in farming activities. Estimation of farming technical efficiency enable farmers evaluates themselves on whether they are technically efficient or not given the resources they have. Hopeful this study is going to inform the farmers on the better use of the farming inputs and the possibilities to improve their efficiency and productivity.

The study can also contribute for the informed decision to the Government, non-Governmental and development partners on the design of policies and programs that will assist farmers to improve productivity and enhance their income.

## 1.5 Scope of the Study

In Tanzania, there are a number of forest reserves and different communities live adjacent to the forest. These forest reserves endowed with different products, also community forests utilize different forest products depending on their needs and availability of these products. Therefore the results that will be obtained from this study might be limited to that particular area, thus unable to make inference to all forest reserves in Tanzania.

## 1.6 Organization of the Study

The rest of the dissertation is organized as follows: Chapter two gives the general overview of forestry and Agricultural sector in Tanzania and Kilosa district in particular. Chapter three reviews theoretical and empirical literatures, based on the relationship between forest conservation and Agriculture in Tanzania and the rest of the world. Chapter four presents methodology used in this study, chapter five presents the empirical results and findings and finally chapter six, gives policy recommendation and conclusion.

# CHAPTER TWO

# OVERVIEW OF FORESTRY AND AGRICULTURE IN TANZANIA

## 2.0 Introduction

This chapter provides an overview of forestry and agriculture in Tanzania in general and Kilosa district in particular. It is organized in six sections. Section one gives overview of forestry in Tanzania, section two describes agricultural sector in Tanzania, section three provide details on REDD program in Tanzania, section four gives the profile of Kilosa District, section five provide information on REDD project in Kilosa and section six is the conclusion.

## 2.1 Forestry in Tanzania

Tanzania has a total land area of 94.5 million hectares of which, the total forest area is estimated at 35.2 million hectares, which is equivalent to 39.9 percent of the country landmass (URT, 2012; UN-REDD, 2013). The country has various forest types include mangrove, coastal woodlands, mountain area forests, Miombo woodlands and Bush-land thicket (the area occupied by each type is indicated on Table 2.1). In addition, the forest categories in Tanzania are based on five ecological regions; Eastern Arc, Mountains in the east, The Albertine Rift in the west, volcanic mountains in the north, Miombo woodlands in semi arid areas and Acacia commiphora in the most arid regions (Chamshama and Vyamana, 2010).

**Table 2.1: Forest Type and Area Covered in Tanzania**

| Forest type | Mangrove forests | Coastal forests | Mountain area forests | Miombo woodland | Bushland thicket |
|---|---|---|---|---|---|
| **Area ( in 00' Hectares)** | 108 | 692 | 18700 | 215082 | 165529 |

**Source**: FAO (2006)

### 2.1.1 The Contribution of Forests to Livelihoods and National Economy

Forests are important assets in Tanzania as it offer numerous goods and services to the economy and to the local livelihood at large. The forests and woodlands, despite its cover of nearly 40 percent of the total land area, they support the livelihoods of 87 percent of the rural poor (Milledge et al, 2007). Forests contribute between 2 to 3 percent of total Gross Domestic Products (GDP). In addition, forests contribute about 2 to 10 percent of the country's registered exports, though some GDP calculations do not take into account the value of forest products that are traded informally, (FAO, 2006).

Forest is the main source of wood fuels, construction materials and other forests products for majority of rural households. It provides over 90 percent of national energy supply through woodfuel and charcoal, and approximately 75 percent of construction materials come from the forest (Milledge et al, 2007; Miles et al, 2009). The construction of rural and urban houses, furniture and other household items is largely based on the use of hardwood timber from the forests.

The beekeeping sector also contribute at large to the National economy, it is estimated that the farmer's income from honey and other forest products from Miombo woodlands is as much as US$ 1050 per ha. (FAO, 2006). According to Monela et al. (2000), honey, charcoal, fuels wood and wild fruits contribute 58 percent of the cash incomes of farmers in six villages surveyed, and honey alone accounts for one third of all cash income in these villages.

Forests also provide sites for tourists' attractions. Tanzania is among the richest countries in terms of biodiversity in the world, is among the countries that have the largest number of mammals, plants, birds, amphibians, reptiles and all of these harboured by the country's forests. Some of the areas like the Eastern Arc Mountain range are internationally recognized as areas with an exceptional concentration of different species that occur nowhere else on the earth (EAMCEF, 2011).

Lastly, mountainous forests play an important role in providing clean and reliable water supply, utilized by people as well as industries situated in urban areas for homes, hydroelectric power generation and industrial uses. About 49 percent of the power supply in Tanzania is derived from hydroelectric power, and approximately 20 percent of the Tanzanian population get water supply from rivers maintained their run off from forest highland areas (Kihwele et al., 2012; UN-REDD, 2013).

### 2.1.2 National Forest Policy

#### 2.1.2.1 History and Features of Tanzania Forest Policies

Tanzania historically experienced various forest policy changes that tried to ensure sound and sustainable management of forest resources. Among them, is the first National policy of Tanzania which enunciated in 1953 and reviewed in 1963. This policy aimed at managing the forest resources sustainably to meet the needs and desires of the society and the nation (URT, 1997). In 1967, forest resources were nationalized followed the Arusha Declaration which aimed at building socialist state in Tanzania.

However, the economy was liberalised during 1980s. In the forest sector, the liberalization paved the way for changing management structure of the forest resources (Kihiyo, 1998). In 1988, the Government of Tanzania initiated the Tanzania Forestry Action Plan (TFAP) as the basis for the development of forest sector, it completed and adopted by the Government in 1989. The TFAP presented a comprehensive analysis of the sector, including reformulation of sectoral objectives, strategies and development programs, though; it did not result in the formulation of a new forest policy and revisions of the sectoral legislation.

In 1998, the Government of Tanzania enacted a National Forest Policy, and its major objective was to enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of the forest resources for the benefit of present and future generations (URT, 1998).The policy aims at promoting participation in forest management through the establishment of Village Land Forest Reserves (VLFRs) and Joint Forest Management (JFM), where in VLFRs, communities are both managers and owners of forests, and JFM is where local communities co-manage National Forest Reserves (NFRs) or Local Authority Forest Reserves (LAFRs) within central and local government authority (Blomley and Iddi, 2009).Other forest related policies in Tanzania are; The Land policy of 1995, which provides the framework for the allocation of land tenure rights (URT, 2012). The National Energy Policy of 2003 which aims at reducing forest depletion from extraction of wood fuel and charcoal (UN-REDD, 2013).

Apart from the forest policy of 1998, forest conservation supporting laws like The Land and Village Land Acts and the forest Act were passed. Land and Village Land Acts were passed in 1999; this empowers village Governments to make by laws as a tools in forest management, whereas the forest Act of 2002 provided a room for communities and private individuals to participate in ownership and management of forests through Participatory Forest Management (PFM), and Environment Act of 2004, which recognizes the importance of forest for climate change mitigation and empowers the Minister for Environment to take action on climate change (LEAD, 2007; Richard et al, 2009).

PFM is a strategy that devolved the control and management of forests from central government to community institutions at local levels. This strategy came after the management of forests by the central government failed. PFM was formalized and introduced into law in 2002 with the passing of the Forest Act of 2002, which provided a clear legal basis for communities, groups or individuals across mainland Tanzania to own, manage or co-manage forests under a wide range of conditions. The PFM is divided into two categories;

Community Based Forest Management (CBFM), this takes place on village lands or private land and the trees are owned and managed by a village council (through a village natural resources committee), a group or an individual. Most of the cost and benefits relating to management and utilization are carried by the owner, and districts only have the role in monitoring, the role of the central Government is minimal (MNRT, 2006). CBFM takes place in unreserved forests which were previously treated as open access by the communities.

Joint Forest Management (JFM), this takes place on reserves land- the land which is owned by either central or local Government. Villagers inter into management agreements and share responsibilities for the management with the forest owner.

There are recognized benefits resulted from PFM establishment such as improvement in forest management compared with areas under direct state management (Blomley et al, 2008). In addition, there are improvement in livelihood benefit and local governance and accountability (TFCG, 2012).

The major goal of participatory forest management was to give forest ownership and management rights to the public especially village-adjacent communities, so as to increase efficiency in management and reduce overexploitation of forest resources, and at the same time, make the resource contribute significantly to the welfare of the adjacent communities.

Despite of the improvements in some areas e.g. increased forest cover, forest in Tanzania is still faced with the following problems: Increased population pressure on land for enhanced agricultural activities, wild fires, livestock grazing, overexploitation, mining and wood extraction for charcoal, timber, poles, firewood and other human activities, natural forests are disappearing at an estimated rate of between 130,000 and 500,000 hectares per year (FAO, 2006). It is estimated that, between 1990 and 2005, Tanzania lost 14.9 percent of its forest cover equivalent to 6,184,000 hectares (Mwakaje et al 2010). Likewise, between 2000 and 2010, the country lost about 10.8 percent of the total forest cover, equivalent to 1.1 percent per annum (Mwakaje et al 2010; FAO, 2010). Table 2.2 shows the changes in forest cover and land distribution in Tanzania between 1984 and 2010. It indicates that, between 1984 and 2010, there is a total forest loss of 10.5 million hectares, equivalent to 23.9 percent.

**Table 2.2: Changes in Forest Cover and Land Distribution in Tanzania**

| Categories | | **Area in hectares** | | | | |
|---|---|---|---|---|---|---|
| | **1984** | **1990** | **1995** | **2000** | **2005** | **2010** |
| Forest | 43 914 900 | 41 494 929 | 39 478 286 | 37 461 644 | 35 445 001 | 33 428 359 |
| Other Wooded Land | 20 152 600 | 18 183 389 | 16 542 376 | 14 901 364 | 13 260 351 | 11 619 339 |
| Open Land | 24 512 500 | 28 901 682 | 32 559 338 | 36 216 993 | 39 874 648 | 43 532 303 |
| Inland Water | - | 6 150 000 | 6 150 000 | 6 150 000 | 6 150 000 | 6 150 000 |
| **Total Country Area** | **94 730 000** | **94 730 000** | **94 730 000** | **94 730 000** | **94 730 000** | **94 730 000** |

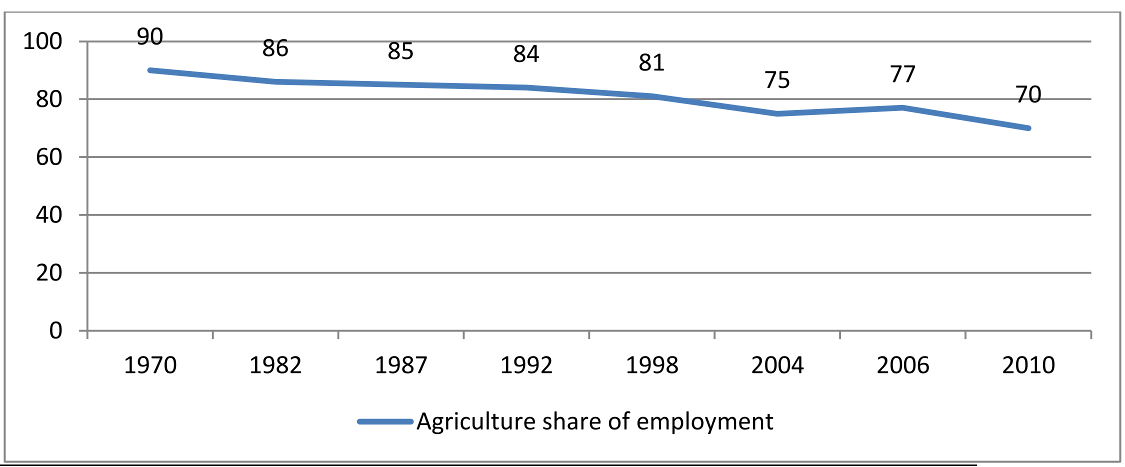
Source: FAO (2010)

Also according to Tanzania Forestry Working Group (TFWG) Information brief (2009); the rate of annual forest loss in Tanzania is about 412,000 hectares. It is noted that forest loss and degradation is occurring inside Forest reserves, but that deforestation is particularly rapid and widespread outside reserved forests. Forest loss inside the forest reserves is the results of failure by designated managers to prevent illegal uses. This can be a result of insufficient resources for enforcement, or of corruption which causes laws to be breached deliberately or not enforced appropriately. Some forests have been cleared through local land use changes, such as shifting cultivation or expansion of agricultural land, which gradually deforests larger areas (TFWG, 2009). Forest degradation is also a major factor in the loss of forest biomass, and consequently, the decrease in carbon storage potential. Degradation comes from unsustainable exploitation of forest for charcoal and timber which is driven by increase in demand both in Tanzania and abroad (TFWG, 2009).

## 2.2 Agriculture in Tanzania

Agricultural sector is said to be the backbone of Tanzanian economy due to the role the sector plays. Despite of the declining trend (see Figure 2.1) of labour force employment in agriculture sector due to shift of population to other emerging and growing sectors especially informal and private sectors (MAFC, 2008), agriculture sector is still the largest employer of the Tanzania population. It employs about 70 percent of Tanzania population and contributes about 24.1 percent of the country's GDP (NBS, 2010). In addition, the sector has linkages with the non-farm sector through forward and backward linkages to agro-processing, consumption and export. It also provides raw materials to industries and a market for manufactured goods (URT, 2013) thus through linkages, it provides support to other sectors.

**Figure 2. 1: Agriculture's Share of Labour Force Employment**

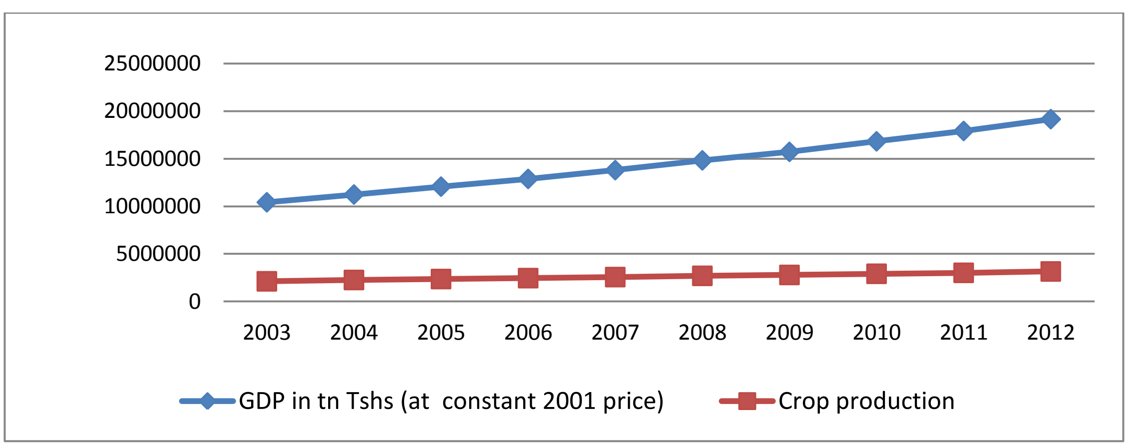



Source: Labour force survey (2006), NBS (2010)

Figure 2.1 shows the trend in labour force employment in agricultural sector. The labour force participation in agricultural sector has been declining since 1970 from high as 90 percent to about 70 percent in 2010. The decline is mainly attributed by the growth of the other sectors which offer attractive incentives as compared to agricultural sector as informal and private sectors. Furthermore, heavy reliance of agricultural sector on rainfall and with the changing rainfall patterns, declining water supply, poor soil quality, disappearing of tree species all have led agriculture unattractive among the youths.

Gross Domestic Product (GDP) of Tanzania is sensitive to agriculture sector's performance especially crop production. Figure 2.2 and 2.3 shows the trends of GDP and crop production in Tanzania for the past ten years (2003-2012).Figure 2.2 shows that both GDP and crop production had a related growing trend from 2003 to 2012. The GDP grew from 10.4 trillion in 2003 to 19.2 trillion in 2012 (at constant 2001 prices), whereas crop production grew from 2.1 trillion in 2003 up to 3.2 trillion in 2012.

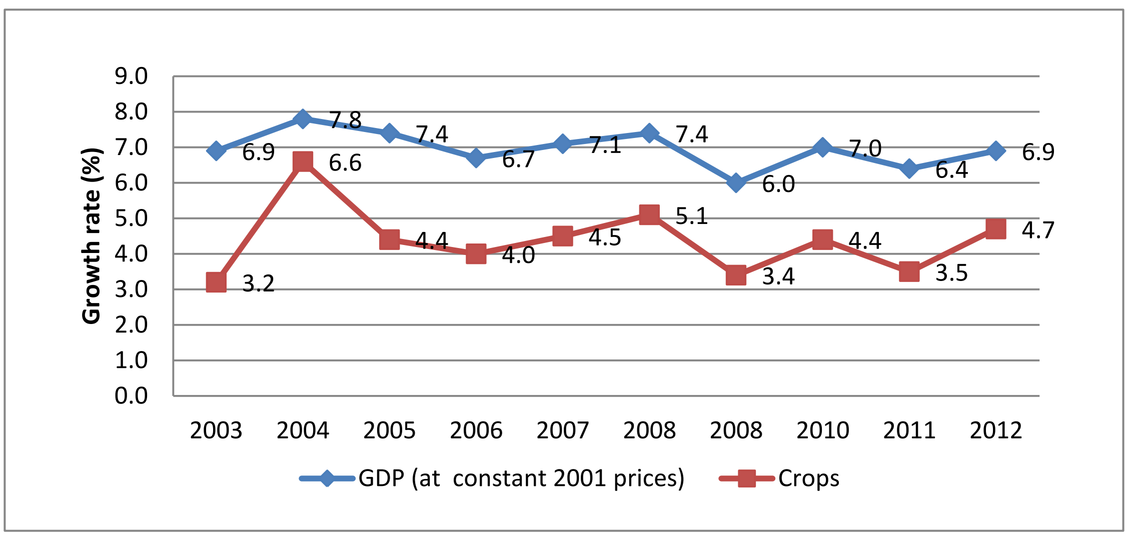
**Figure 2. 2: Trend in GDP and Crop Production in Tanzania**




**Source**: Author's computation by using data from NBS (2012)

Figure 2.3 shows the similar fluctuating trend between the GDP growth rate and the rate of crop production. From 2003 to 2004, crop production grew from 3.2 percent to 6.6 percent while GDP growth rate increased from 6.9 to 7.8 percent. Likewise, the decline of crop production from 6.6 to 4.4 in 2005 led the fall of GDP growth rate from 7.8 to 7.4 percent in 2005. The same to subsequent years including the past last year, which shows crop production rose from 3.5 to 4.7 percent and GDP grew from 6.4 to 6.9 percent as well.

**Figure 2. 3: GDP and Crop Production Growth Rates (%)**



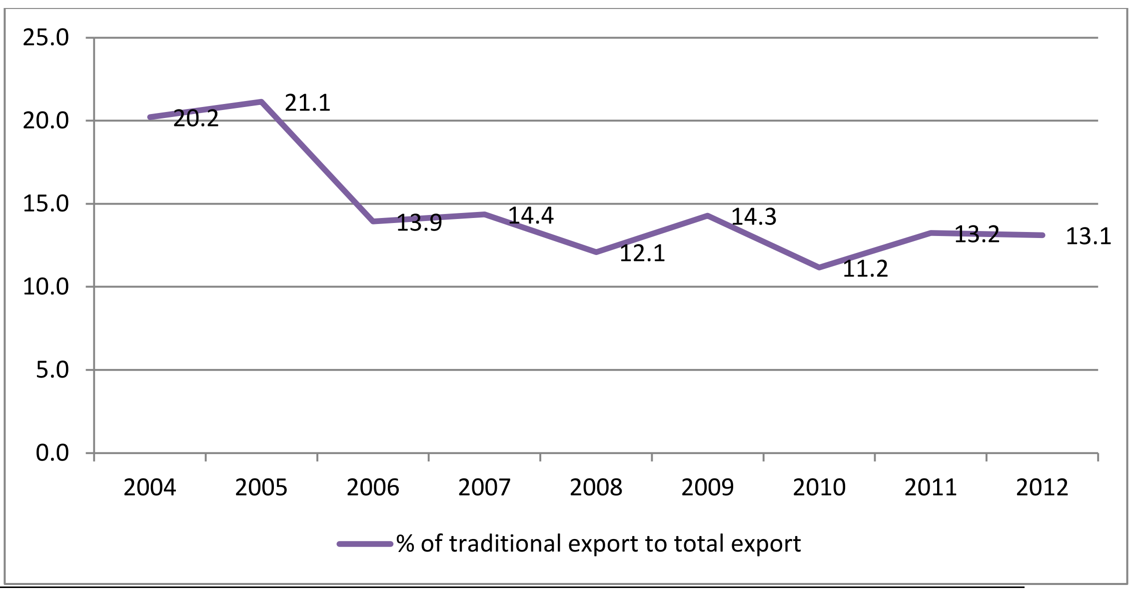

**Source**: Author's computation by using data from NBS (2012)

Agriculture sector contribute between 10 to 15 percent to merchandise export through traditional exports (NBS, 2010). Traditional agricultural exports include major cash crops; coffee, cotton, tea, tobacco, cashewnuts, cloves and sisal, specifically under crops category in Agriculture sector. The sector contributed about 13.1 percent in 2012

(NBS, 2013). However, the contribution is decreasing over time due to fall in prices of traditional export in the world market (MAFC, 2013).

Figure 2.4 indicates the decline in contribution of traditional export over the last 9 years. In 2004 it was 20.2 percent, and then rose to 21.1 percent in 2005, this is higher compared to 13.1 percent of 2012.

**Figure 2. 4: Contribution of Tradition Export to Merchandise Export (%)**




Source: Author’s computation using data from NBS (2012)

The agricultural economy is dominated by food crop production where 5.1 million hectares are cultivated annually, of which 85 percent is under food crops (NBS, 2012). Major staple crops cultivated include maize, sorghum, millet, rice, wheat, pulses (mainly beans), cassava, potatoes and bananas. The sector also is dominated by small-holder farmers cultivating average farm size of between 0.9 to 3.0 hectares each(NBS, 2012).More than 95% of Tanzanian's crop area is cultivated by hand hoe, 18% by ox-plough, less than 10% by tractor, whereas more than 96% depending on rainfall(MAFC, 2008). Agricultural production in Tanzania is dominated by local communities who rely on poor technology and heavily depending on climatic condition, majority of them engaged in sole subsistence farming with just one third of farmers selling at least some of their products (NBS, 2012).

Due to the presence of water resources such as rivers and lakes, the country has irrigatable land of about 2 million hectares (World Bank, 2001), but only 150,000 hectares are cultivated under irrigation. In addition, only 4 percent of farmers are using irrigation in at least one of their fields which corresponds to less than 2 percent of cultivated fields (NBS, 2012).

The use of fertilizers in Tanzania, whether organic or in-organic is very low, about three quarters of the fields do not use any fertilizer. Despite of the government efforts to increase the use of fertilizer like the introduction of National Agriculture Input voucher scheme in 2008 and others did not have impact as it remains about 15-20 percent of the fields uses fertilizers (URT, 2006, NBS, 2012).

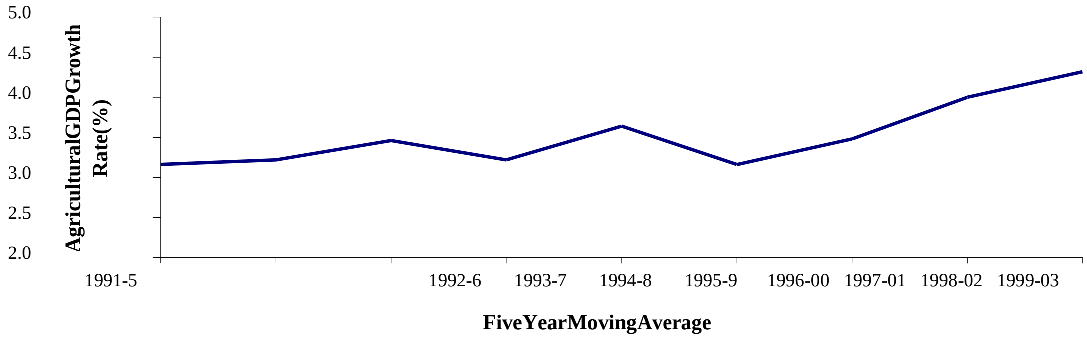
The use of purchased seeds among farmers is very low as well; about 80 percent of Tanzanians do not plant improved and certified seeds (NBS, 2010). The large quantity of seeds comes from the farms themselves, harvested from the last year's growth.

Access to formal credit from financial institution such as commercial banks, SACCOS or other formal lenders is still very restricted in Tanzania agricultural sector. The percentage of farmers who received credit for purchase of their inputs such as improved seeds, fertilizers or fungicides is only about 2.2 (NBS, 2012).

As it was demonstrated, Tanzania has an area of 94.5 million hectares of land, out of which 44 million hectares are classified as suitable for agriculture. However, part of the arable land may not be suitable for agricultural production for variety of reasons including low level of rainfall, poor soil fertility and erosion. According to National Bureau of Statistics (NBS, 2003), out of 44 million hectares, only 9.1 million hectares were under cultivation in 2002. In 2008, Tanzania Investment Centre (TIC) reported that the area under cultivation was 10.2 million hectares (Sulle and Nelson, 2009), thus, about 12 percent increase in agricultural land from 2002 to 2008, translating into approximately 2 percent per annum.

Over the 1990's, average agricultural growth was 3.6 percent, which was higher than in the 1970's and 1980's, when annual agricultural growth averaged 2.9 and 2.1 percent respectively (URT, 2006). Furthermore the agricultural growth was about 4.7 percent on average in 2000's (NBS, 2010) which shows moderate improvement in the sector. Figure 2.5 shows the five year moving average agricultural GDP growth rates. It shows from 1991-2000, average agricultural GDP growth rate in Tanzania was 3.3 percent, and 4.3 percent over the 1999-2003. Thus, implying that agricultural sector has grown by less than 5 percent in the past four decades.

**Figure 2. 5: Five Year Moving Average- Agricultural GDP Growth Rates (%)**

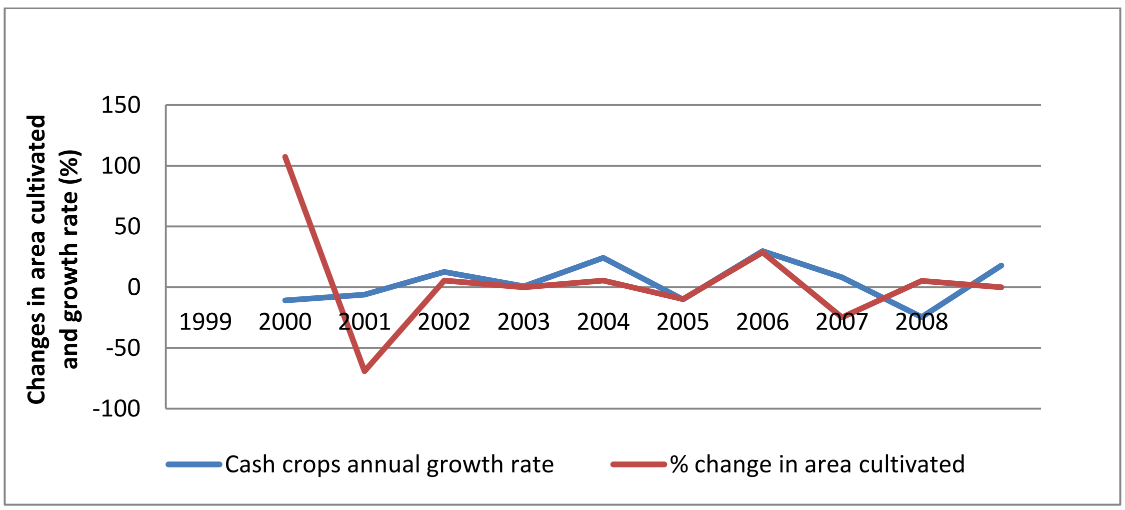



Source:NationalAccounts

In addition, there is a similar trend between major cash crops production (cotton, coffee, tea, sisal, cashewnuts, sugar and tobacco) and the size of the cultivated area. Figure 2.6 shows the trends in area cultivated of major cash crops and their production from 2001 to 2008. Generally, fluctuation in production of cash crops and area cultivated influenced by the weather conditions, availability of production inputs such as fertilizers and pesticides, and variation of prices in the world market due to farmers' inertia (MAFC, 2008) thus the sharp decline of the area cultivated from 2000 to 2001 was due to unfavourable weather condition and decline of cash crop prices in the world market that led the farmers reduced the size of area cultivated. However, the figure shows related trends for subsequent years from 2001 i.e. from 2001 to 2002, production rose by 12.6 percent when the area cultivated increased by 5.5 percent, then both declined in 2003. The Figure shows similar trend up to 2007.

Agricultural growth in Tanzania as in many Sub-Saharan Africa (SSA) countries may largely be determined by area expansion and to a lesser extent by increased productivity (Nkonya et al, 2008).In addition, agricultural activities are among the factors which affect the forest condition through forest clearing (others are wild fires, livestock grazing, overexploitation, mining and wood extraction for charcoal, timber, poles, firewood etc. (FAO, 2006).

**Figure 2. 6: The Relationship between Annual Growth Rate of Cash Crops Production and Area Cultivated**




Source: Author's computation, data from MAFC (2008)

As the majority of rural communities depend heavily on agriculture and forest products for supporting their daily life, giving the ownership rights to the village communities and enforcement of the rules will only lead to displacement effects, whereby communities will extend their extractions efforts into none protected forest (Robinson and Lokina, 2011).According to Luoga et al. (2000), one way to build capacity for managing natural resources is to improve farm productivity and help people to engage in alternative income generating activities. Therefore, improving agricultural productivity, will to a much extent, enhance rural incomes and reduce forest dependency.

## 2.3 Tanzania and REDD Program

Reduced Emissions from Deforestation and Forest Degradation (REDD) is the central strategy in efforts to reduce global greenhouse gas emissions in order to help prevent climate change. REDD strategy came into being based on the fact that forests store a great deal of the world's carbon, and an estimated 12-18 percent of global carbon dioxide emissions come from land use change, mainly from deforestation and forest degradation (TFWG, 2009). Deforestation and forest degradation reduce the amount of carbon dioxide absorbed and stored in trees. These processes also release carbon stored by forests into the atmosphere, often through burning or through changes to forest soils and below-ground biomass.

Deforestation rates in developing countries tend to be high, particularly from countries in the tropics with high level of forest cover. In these countries, the rate forest extraction activities like timber production are very high and their trade is often not well controlled, causing large scale and unrecorded losses of carbon from forests (TFWG, 2009). The idea behind REDD is that developed countries in which majority of them are highly industrialized, and with high greenhouse gas emissions will pay developing nations which have high level of forest cover to reduce their current rates of deforestation.

To address effectively the issues of deforestation and forest degradation in Tanzania, REDD program stated by finding out what are the basic overall causes and drivers of deforestation and forest degradation and designing REDD in a way that takes account of underlying drivers of deforestation. The program found problems facing forests in Tanzania as discussed above: degradation is driven by rapidly rising demand for forest products like charcoal, timber and other products. Government factors related to land tenure underlie both over-exploitation of forest and forest clearance at local level. Forest clearing is caused by shifting cultivation or agriculture expansion, demographic expansion, improvement in transportation and so on.

The basic objective of REDD within the context of the global negotiations over climate change, is to use international financial transfers to reduce the loss and degradation of forest in Tanzania and other developing countries. That revenue will create the necessary resources and incentives at national, district, village and household level for conserving forests by stopping or slowing the current trends of forest loss and degradation (TFWG, 2009).

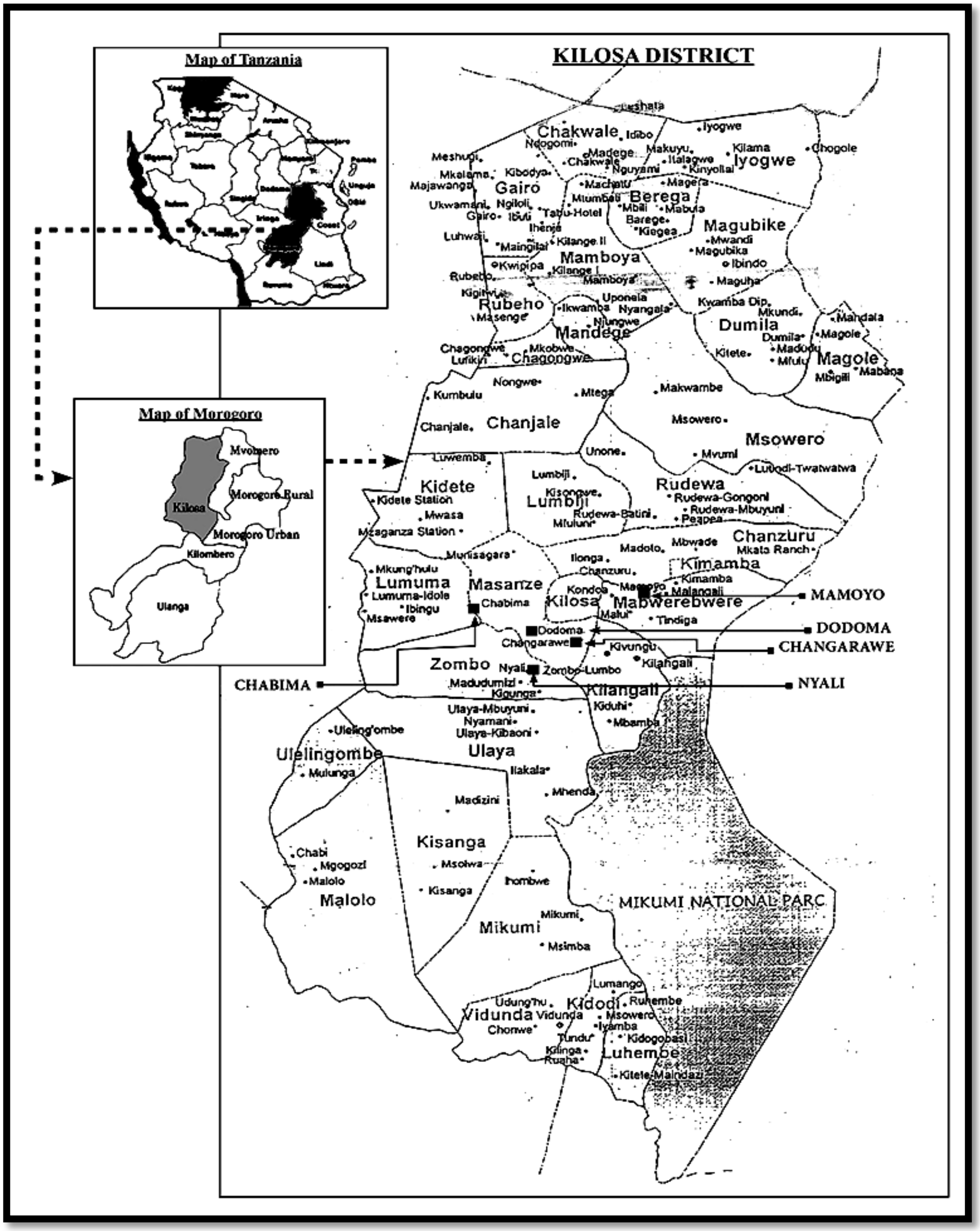
## 2.4 Profile of Kilosa District

### 2.4.1 Location

Kilosa District is the one of the seven districts of Morogoro Region in Tanzania (other districts are Kilombero, Morogoro urban, Morogoro rural, Mvomero, Ulanga and Gairo). Kilosa district is bordered to the north by Manyara region, to the northeast by Tanga region, to the east by Mvomero district, to the southeast by Morogoro rural district, to the south by Kilombero district, to the southwest by Iringa region and to the west by Dodoma region (see Figure 2.7).

The district is located approximately 300 km inland from the coast and Dar es Salaam, and it is situated along one of the old East African caravan routes that extend from Bagamoyo to the eastern part of today's Congo, where the towns served as 'slave calling stations' for the caravans to rest and refill their supplies (Benjaminsen, et al. 2009). Kilosa District covers 14,918 square kilometers (5,760 sq mi) and occupies about 20 percent of the area in the region (Kilosa district council, 2010).

**Figure 2. 7: Map of Kilosa District**




**Source**: Kilosa District Natural resources office (2013)

### 2.4.2 Population

According to the 2012 Tanzania National Census, population of Kilosa district was 438,175 people. About 20 percent population of Morogoro region live in Kilosa District. It is the second District in Morogoro Region to have small household size of 4.2 members. The first is Morogoro Municipal which has an average household size of 4.1 members, whereas other districts have between 4.3 up to 5.2 members (see Table 2.3). The district has three major ethnic groups; Kaguru in the north, Sagala in the central zone and Vidunda in the south. However, many people from other ethnic groups migrated to the area in the last decades and adding to the existing ethnic groups (Kilosa District council, 2010).The district has total number of 164 villages and average number of people per village is 2,672 people.

**Table 2. 3: Morogoro Population**

| DISTRICT / COUNCIL | TOTAL | MALE | FEMALE | HOUSEHOLD SIZE | Population percentage |
|---|---|---|---|---|---|
| Total | 2,218,492 | 1,093,302 | 1,125,190 | 4.4 | 100.0 |
| Kilosa | 438,175 | 218,378 | 219,797 | 4.2 | 19.8 |
| Morogoro | 286,248 | 140,824 | 145,424 | 4.2 | 12.9 |
| Kilombero | 407,880 | 202,789 | 205,091 | 4.3 | 18.4 |
| Ulanga | 265,203 | 131,562 | 133,641 | 4.9 | 12.0 |
| Morogoro Municipal | 315,866 | 151,700 | 164,166 | 4.1 | 14.2 |
| Mvomero | 312,109 | 154,843 | 157,266 | 4.3 | 14.1 |
| Gairo | 193,011 | 93,206 | 99,805 | 5.2 | 8.7 |

Source: National Census Survey (2012)

### 2.4.3 Vegetation and Wildlife

The vegetation in Kilosa District is characterized by both Mediterranean and tropical types; typically it consists of Miombo woodland with grass and shrub covering the soil (Kilosa District Council 2010). Most of the forests are found on the western part of the District along the Eastern Arc mountain range, more specifically around Rubeho Mountains. The Eastern Arc Mountain range contains several unique ecosystems with a variety of species. Many of them are endemic to the area, and are internationally recognized as an area with an exceptional concentration of different species that occur nowhere else on earth (EAMCEF, 2011). Even though the Rubeho Mountains are generally poorer in endemic species than other areas of the Eastern Arc, less species rich mountains will still contain significant levels of endemic species (Burgess, et al. 2007). Wildlife also plays a significant role in Kilosa District through Mikumi National Park; it is a main source of revenue to the Government through tourism (Shishira et al. 1997).As for the climatic conditions, the western forests serve as an important catchment for the Wami River going eastwards, and three branches of the Ruaha River draining the southern end of the district (Dyngel and Eriksson 2011; Shishira et al. 1997).

### 2.4.4 Climate

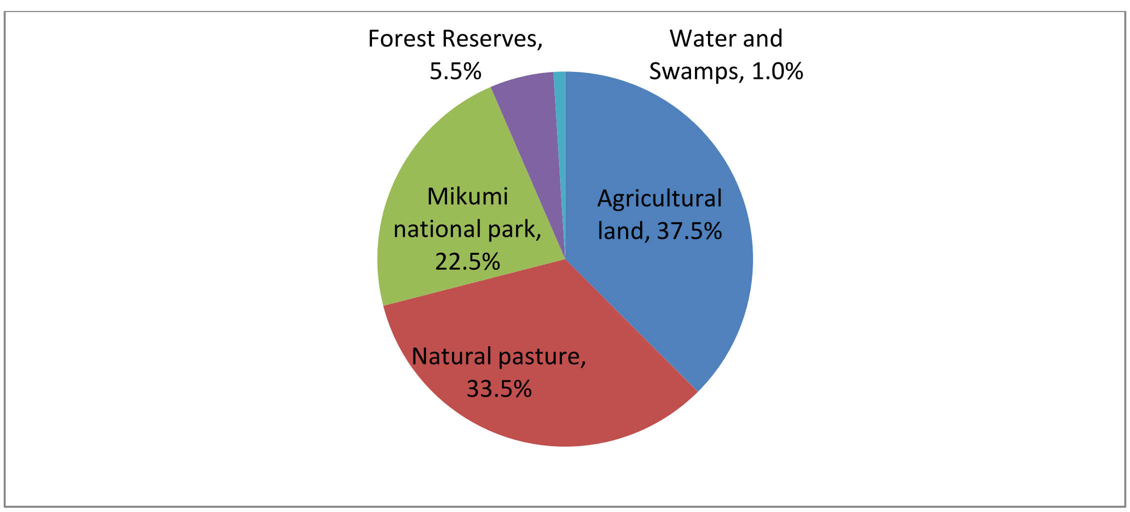
Kilosa District is characterized by semi humid climate, receiving an average rainfall of 800 mm annually, the district receives rainfall in eight months (from October to May).The amount of rainfall varies from year to year, falling in two periods of the year

– the short rains in November and December and the long rains from mid-February through April (Benjaminsen et al. 2009). Temperature ranges from 18$^{0}$C in the hills and highland areas to as high as 30$^{0}$C in the lowland areas (Kilosa District council, 2010).

### 2.4.5 Land Use

The major land types in Kilosa can be divided into five different categories, as shown by Figure 2.8; agricultural land which is the largest, occupy about 37.5 percent of the total district area, natural pasture (33.5%), Mikumi National Park (22.5%), Forest Reserves (5.5%) and urban areas, water and swamps (1%) (Kilosa District Council, 2010). Both agriculture and livestock grazing are practiced and found on general, village, and private lands, while Mikumi National Park and Forest Reserves are controlled areas and state owned.

**Figure 2. 8: Distribution of Land Use in Kilosa District**




Source: Kilosa District Council (2010)

### 2.4.6 Forestry in Kilosa

Most of the forests are found on the western part of the district, particularly around the Eastern Arc mountain range, and include forest reserves, community forests and public forests (Shishira et al. 1997).The District has Forest Reserves that are managed centrally by the Government through the Tanzania Forest Service (TFS); they cover the total area of 106,983 hectares. Most of them are located on steep slopes around the catchment area for the Wami river system, while the rest are found on gentile sloping terrain within and around Mikumi National Park. Besides these forest reserves there are governmental and privately owned soft wood plantations, comprising mainly of pines, Cyprus and eucalyptus meant for the production of timber and poles (Shishira et al. 1997). Community forests are found within villages while public forests are all forest outside the forest reserves, which are not controlled by villagers. These forests are exploited for various purposes such as poles, timber, firewood and charcoal, also they are used for hunting wild animals. The District Natural Resource Office is responsible for the management of the district forests that is outside of Mikumi National Park.

Kilosa District is faced with two major forces that cause deforestation: forest clearing for agriculture and plantations and bio-mass for energy consumption which occurs as the result of an increasing urbanization and population (Shishira et al. 1997; Hall et al. 2009).Others include timber production and bush fires which also seen as important and corresponding drivers of deforestation. Kilosa as one of the districts in Tanzania is heavily depends upon the forest for energy sources such as charcoal and firewood which consists of almost 90% of the energy consumption nationwide (World Bank, 2009).This nationwide demand for biomass energy have had huge effects on Kilosa District, where closeness to towns such as Dar es Salaam and Morogoro have facilitated it good access to large markets and resulted in extensive charcoal production.

Likewise, forest provides energy in the form of firewood for rural households and brick making as well as for the Kilombero Sugar Factory that neighbours Mikumi National Park (Shishira et al. 1997). Forest degradation is influenced by the location, places with easy access to and from urban areas, bringing up extensive forest extraction for commercial purposes.

With most of its population depending on agriculture, forest clearing for agriculture poses a major threat to forest resources (Kilosa District Council 2010). This is not necessarily due to land shortage but may rather be explained by declines in soil fertility and limited use of fertilizers. The expansion of agricultural land would then, first and foremost be a mean for increased production (Shishira et al. 1997; Kilosa District Council 2010).

### 2.4.7 Agriculture in Kilosa

Over 77 percent of people of Kilosa District are fully depending on agricultural activities (URT, 2003). With its demographic conditions, ranging from a plateau characterized by seasonally flooded plains and hills, to mountainous areas with altitudes surpassing 2000m, Kilosa District offers a variety of agro-ecological conditions for farming (Maganga et al. 2007). The variation in the types of crops grown reflects the different agro-ecological zones, maize is the main food crop which is grown in many areas, but is mainly cultivated in the North-western part. Rice is also an important food crop, mostly grown under rain-fed conditions in the flood plains, but is also to be found in small-scale irrigated rice farms (Shishira et al. 1997).Other important food crops include millet, cassava, beans, bananas and cowpeas (Kilosa District Council 2010) while cash crops are sisal, cotton, coffee, wheat, cashew-nuts, coconuts, sugar cane and tobacco.

The agricultural system is characterized by both small scale (about 90%) and large-scale farm holders (10%) where the average farmland is less than 1 hectare (Shishira et al, 2007). The small-scale farm holders are subsistence farmers who produce mostly for domestic use, where only the surplus production is sold. There is a limited use of inputs such as improved seeds, fertilizers and/or manure, and the majority (95%) use hand hoe for cultivation (Shishira et al. 1997; Kilosa District Council 2010). Large-scale farms occupy part of the suitable land for agriculture, and holds about 5% of the total land in the District. They comprise mostly of sisal estates and many of them are owned by Tanzania Sisal Authority or private companies such as Katani Limited (Kilosa District Council 2010).

Due to intensive production without the help of agricultural inputs and changes in climatic conditions, Kilosa District experienced a decline in production, where in

2006/2007 Kilosa District had to import as much as 24,000 tons of food to support its population (Kilosa District Council 2010). Such challenges make it difficult to sustain and/or improve the agricultural production, and as a result, extensive land clearing has been carried out to provide new land for agriculture (Shishira et al. 1997). Although agriculture also is practiced in the highlands, it is within the plains and plateau zones that most of the cultivation takes place. These are also the zones that have traditionally suffered the highest rates of deforestation.

## 2.5 Kilosa District and REDD

Kilosa District is one of the areas in Tanzania that have endowed with mass forest cover. Forests in Kilosa district are found on the western part of the district along the Eastern Arc Mountain range, more specifically around Rubeho Mountains. However, these forests are faced with deforestation and forest degradation due to expansion of agricultural activities and demand for bio-mass for energy consumption (Shishira et al 1997).

REDD program was introduced in Kilosa in 2009 for the same aim of reducing greenhouse gas emissions from deforestation and degradation in the district through the project 'Making REDD work for the communities and forest conservation in Tanzania'. Kilosa district has 164 villages, out of that, 13 villages are under REDD pilot program.

The project 'Making REDD work for the communities and forest conservation in Tanzania' is being implemented in two sites; Lindi project site and Kilosa and

Mpwapwa project site with a total of 36 villages. There are 17 villages in Lindi project site, 13 villages in Kilosa and 5 villages in Mpwapwa district (TFCG, 2012). The project was launched in Kilosa in September 2009. It has duration of 5 years that run from September 2009 to August 2014. The project aims at fulfilling REDD objectives in ways that provide direct and equitable incentives to communities to conserve and manage forests sustainably. It achieves this by supporting the development of a Community Carbon Cooperative hosted within the existing Network of Tanzanian communities engaged in participatory forest management. The Cooperative aggregates voluntary emission reductions from its members and market them according to internationally recognized standards. A proportion of project funds and carbon market revenue is channelled directly to the communities on a results-based basis thereby maximizing incentives to maintain forest cover and reduce deforestation.

The major drivers of deforestation and forest degradation in Kilosa district are agriculture, fire, charcoal, timber, poles, firewood, livestock and geographical location (Forester-Kibuga and Samweli, 2010). There is a natural expansion of agricultural land due to population increase and also there is some shifting cultivation which is mostly driven by cultivation of sesame in which farmers abandon *shamba* when its fertility begins to decrease. However, majority of farmers have permanent *shambas* and few of them clear new *shambas* in the forest, but only once every 6-8 years (Forester-Kibuga and Samwel, 2010).By recognizing that, the project realized that by engaging themselves in training directly to the villagers on modern agricultural practices will ensure increase in productivity, reduce land clearing and shifting cultivation.

### 2.6 Conclusion

As pointed above, forest resources in Tanzania and Kilosa District in particular facing deforestation and degradation caused by increased population pressure on land that enhance expansion of agricultural activities and other human activities. Agricultural activities are the main causes of deforestation and forest degradation due to poor application of modern farming, in addition, rural households as well as communities living adjacent to the forest depend mainly on agriculture and forest products for supporting their daily life. Hence improvement in agricultural activities could be a better solution for reducing deforestation and forest degradation.

# CHAPTER THREE

# LITERATURE REVIEW

## 3.0 Introduction

The purpose of this chapter is to present information based on the relationship between improvement in agricultural production and forest conservation through various studies. It is divided into two main parts, theoretical and empirical literatures and presented as follows:

## 3.1 Theoretical Literature

The theory of technical efficiency can be used to describe how producer can produce maximum feasible output by using the available inputs. It determines whether productivity is efficient or not. Production is said to be technically inefficient if it is possible to produce a given level of output with less of at least one input and no more of another (Gravelle and Rees, 2004). A producer may be inefficient due to the following reasons (i) failing to achieve maximum output from a given level of inputs (technical inefficiency),(ii) using inputs in wrong proportional given their prices (allocative inefficiency) and (iii) failing to achieve the optimum scale operation (scale efficiency). The product of technical efficiency and allocative efficiency generate overall economic efficiency. Inefficiency increases the costs of production, and thus reduces profit that can be generated from production activities.

Technical efficiency can be illustrated by alternative production frontier models such as deterministic frontiers, stochastic frontiers and panel data models (Battese, 1992). The basic structure of the stochastic frontier model is depicted in Figure A1 in the appendix, the productive activities of two firms, represented by $i$ and $j$ are considered. Firm $i$ uses inputs with values given by (the vector)$x_i$and produces output $Y_i$, but the frontier output$Y_i^*$exceeds the value on the deterministic production function,$f(x_i, \beta_i)$ because its productive activity is associated with favourable conditions for which the random error$V_i$ is positive. However, firm $j$, uses inputs with values given by (the vector)$x_j$ and produces output,$Y_j$which has corresponding frontier output,$Y_j^*$, which is less than the value on the deterministic production function, $f(x_j, \beta_j)$because its productive activity is associated with unfavourable conditions for which the random error $V_j$ is negative. In both cases the observed production values are less than the corresponding frontier values, however the (unobservable) frontier production values lie above or below the deterministic production function depending on the existence of favourable or unfavourable conditions beyond the firm's control.

Brundtland Commission (1987) argues that poor farmers have few options beyond degrading natural resources in their struggle to survive. This argument indicates that communities especially those living along forest peripheries, their only income generating option apart from agriculture is extracting the forest resources as they are poor and unable to access other sources of income. Hence improving their production efficiency enhances rural incomes and potentially reduces degradation on natural resources.

Paarlberg, (1994), Pagiola et al (1997) argue that increasing agricultural production is often seen as a solution to the need to increase food production while preserving natural habitats.

Neumann and Hirsch (2000) point out that while Non Timber Forests Products (NTFPs) contribute to household income in many places, this contribution is uneven geographically and across social groups and can be highly differentiated by gender, class and ethnicity. There are many complex factors that affect use of forests in rural areas of developing countries.

According to Angelson and Kamowitz (2001), the degree to which agriculture intensification can help to alleviate tropical forest decline remain unclear. New technologies that increase the returns to agriculture can reduce the need for subsistence-driven land clearing, but raising incomes and the returns to agricultural activities can also provide incentives to convert forest to farmland or other uses. Though they conclude that, an inverse relationship exists between rural wages and deforestation rates. This is due to the fact that the incentive to clear the forest is strongly influenced by cost of access and returns to alternative activities.

Shively (2001) pointed out; the impact of technical progress depends on both direct impacts arising in the labour market and the indirect impacts arising in commodity markets. Growth in lowland production tends to pull labour out of upland production. Also, production increased demand for upland products which resulted in commodity production and reducing forest degrading activities.

Van Soest et al (2002) argue that, new technologies typically render agriculture more profitable and can thereby increase incentive to clear forests. But market conditions, institutional factors and technology characteristics also influence the outcome.

## 3.2 Empirical Literature

Kohlin and Ostwald (2001) examined the welfare and environmental effects of Orissa village plantation in India. The results based on Kuhn-Tucker conditions analysis, shows that plantations have the potential for substantial welfare improvement for the target population and decreased pressure and time for collection of natural forest products.

Bluffstone et al. (2001) developed labour allocation model of Bolivian Andes and tested the hypothesis that better management and regulation translates into time saving for households engaged in forest-related activities, such time saving can then be used in other productive activities like off-farm employment. They found that clear rules reduce the time allocated by the household to grazing and fuelwood collection activities, and the reduction in time spent in forest-related activities improves the quality of forest resources.

Tachibana et al (2001) presented a dynamic model of agricultural Intensification versus Extensification in the Northern hill region of Vietnam for the purpose of testing its implication on regeneration of the forests. The results, based on commune level data suggest that the choice between intensification and extensification is relevant in the hilly areas with limited flat land and sloped upland, and that strengthened land rights particularly that on upland, tend to deter deforestation.

Shylajan and Mythili (2003) explored the factors determining the dependency of local people on a protected forest area for commercial purposes in India. Variables like occupation income, income from cultivation, farm size, household labour, educated adult and location (distance) were included in forest dependency model. Based on the data from a household budget survey, the study findings show the significant inverse relationship between households income from non-wood forest products (NWFP) and income from cultivation which indicates that households with higher agricultural income depend less on forests products.

Prabodh (2005) examined Technical efficiency in agriculture and dependency on forest resources in Sri Lanka. Based on cross-sectional data from 442 households in Badulla District, the findings show that the mean technical in agricultural farming in the forest peripheries ranges between 67-73 percent, the study used the factors such as age, education, experience, extension and nutrition status of household head are mainly responsible for determining the level of inefficiency. Further, the study findings shows, factors such as technical inefficiency in agriculture, off-farm income, wealth and diversification index had negative and significant effect on forest dependency.

Fisher and Shively (2006) examined the impact agricultural intensification policy (Starter Pack Scheme) on smallholder-led forest degradation in Southern Malawi. The findings indicate that households that received a free packet of inputs (a starter pack) had lower levels of forest extraction than households that did not receive a starter pack. Further, the study examined the influence of households' characteristics such as age of the household head, education, share of men among household members and farm size. The results show that forest extraction is positively related to share of men, negatively and significantly related to education. The study suggests that any improvements in agricultural production are likely to reduce forests extraction, thus, by making farming more profitable, increase households' incentive to work on farm and, subsequently reduce labour allocations to forest extraction.

The study by Lepatu at al. (2009), examined the factors which influencing forests dependency for households living around Kisane Forest Reserve (KFR) in Botswana. The study included factors such as age, gender, education, household size, total wealth asset and number of years of living in the area. The results show that rich households were significantly less dependent on forest resources, also forest dependency was positively and significantly associated with family size, that is larger households tended to derive more income from the forest. This indicates that for large family size, income generated from agricultural production is not sufficient to meet their daily needs, thus highly depended on forest resources.

## 3.3 Conclusion

Theoretical literatures are not clear about the existing relationship between improvement in agricultural production and forest extraction as pointed out by Angelson and Kamowitz (2001). Some of the papers like Van Soest et al (2002) argue that increase in farming productivity increase agricultural incentives that induces further conversion of forest land to agriculture, on the other hand, Brundtland Commission (1987), Shively (2001) point out that the increase in returns to agriculture enhances rural income and thus hire more labour and pull rural households out of forest extraction. Despite limited empirical studies that have been done so far, most of the studies like Prabodh (2005) Fisher and Shively (2006), Lepatu at al. (2009) support the argument that improvement in agricultural production reduces forest degradation and extraction. This study examines the relationship between agricultural production and forest resources extraction in Tanzania and particularly in Kilosa district which possibly have never been done.

# CHAPTER FOUR

# METHODOLOGY

## 4.0 Introduction

This chapter presents the methodology used in determining the influence of technical efficiency in agriculture on forest conservation. It describes the theoretical and empirical specifications of technical efficiency and forest resources extraction models. Section one describes the area where the study conducted, section two explains the source, type and method used in data collection, section three and four describe theoretical and empirical specification for stochastic frontier and technical inefficiency models, whereas, section five describes empirical specification of forest resources extraction model. Further, section six specifies the hypothesis of this study, section seven describes the choice of variables and their measurement, section eight describes the analytical technical used by the study and lastly, section nine which provides the conclusion of the chapter.

## 4.1 Study Area

The study was conducted in Kilosa District in Morogoro. The District constitutes villages located along the forest peripheries and majority of the villagers practicing farming and forest extraction activities. This facilitated the analysis of farm productivity as well as its influence on forest conservation by these communities to be appropriate. In addition, the study intended to compare technical efficiency levels between villages where REDD project is operated and those villages which are outside the project. Five villages in Kilosa District were selected for study; Nyali, Changarawe, Chabima, Dodoma-Isanga[1] and Mamoyo (see Figure 2.2), where three of them; Nyali, Chabima and Dodoma Isanga were under REDD project. A total of 301 households were picked randomly from each selected village. The number and percentage of households to total village households is presented in Table 4.1.

**Table 4.1: Sample Size and the Total Village Households**

| Village | Village total Households | Number of households interviewed | Percentage of household interviewed |
|---|---|---|---|
| Nyali | 456 | 61 | 13.4 |
| Changarawe | 615 | 68 | 11.1 |
| Chabima | 313 | 61 | 19.5 |
| Dodoma Isanga | 421 | 60 | 14.3 |
| Mamoyo | 305 | 51 | 16.7 |
| **Total** | **2110** | **301** | **14.3** |

Source: Village offices (2013)

The difference in number of responses from these villages was due to; some villages had less number of households practicing farming activities (e.g. Mamoyo) and as the study excludes the households who were not engaging in crop cultivation. Another reason is the nature of the settlement, some live in nuclear settlements that made easier to approach and interview (e.g. Changarawe) while others live far apart (e.g. Chabima).

## 4.2 Source, Type and Method of Data Collection

The general objective of this study was to estimate agricultural productivity

[1] Dodoma Isanga village is divided into three divisions; Dodoma Isanga, Dodoma Kati and Dodoma Kipekenya, thus respondents were randomly selected from each division.

particularly technical efficiency, and its influence on the forest conservation. The study utilized both primary and secondary data to obtain important information concerning the study. Secondary data were collected from National Bureau of Statistics (NBS), National Sample Census of Agriculture (NSCA), 2002/03 and National Panel Surveys (NPS) of 2008/2009 and 2010/2011.

Primary data were collected from households in selected villages, questions were directly asked to the households to get information related to the study. Basic information such as demographic, location of forest and villages were obtained from Kilosa District office and District Natural resources office.

Data were collected by using questionnaires in which all important information needed by the study included in questionnaires. Questions for household characteristics, resources use and social-economic data were included in questionnaire.

### 4.3 Theoretical Specification for Stochastic Frontier and Technical Inefficiency Models

Stochastic frontier production function was independently proposed by Aigner et al (1977) and Meeusen and van den Broeck (1977), later modified by Jondrow et al (1982). Other models have been suggested and applied in the analysis of cross sectional and panel data, reviews of some of these models and their applications are given by Battese (1992), Bravo-Ureta and Pinherio (1993) and Coelli (1995). Some models have been proposed in which the technical efficiency effects in the stochastic frontier model are also modelled in terms of other observable explanatory variables (see Kumbhakar et al, 1991, Huang and Liu, 1994, Battese and Coelli, 1995).

The stochastic production function is defined by

$$y_i = f(x_i, \beta)exp(V_i - U_i) \quad i = 1,2, \ldots \ldots . . N \qquad 4.1$$

Where $V_i$ is a random error having zero mean, which is associated with random factors e.g. measurement errors, weather condition, industrial actions, etc. not under the control of the firm. The model is such that the possible production$y_i$ , is bounded above by the stochastic quantity, $f(x_i, \beta)\exp(Vi)$; hence the term stochastic frontier. The random errors,$V_i$, i = 1,2,……N were assumed to be independently and identically distributed as $N(0,\sigma_v^2)$ random variable independent of the$U_i's$ which were assumed to be non-negative truncations of the $N(0,\sigma_u^2)$ distribution (i.e. half normal distribution) or have exponential distribution.

The variance parameters $\sigma_v^2$ and $\sigma_u^2$ are of critical importance in this model as far as technical efficiency is concern. They are expressed as follows:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \qquad 4.2$$

$$\gamma = {\sigma_u^2}/{\sigma^2} \qquad 4.3$$

Where $\sigma^2$= overall farmers' output deviations, $\gamma$is the ratio of farmers' output deviations due to technical inefficiency to overall deviations. It ranges from 0 to 1, when $\gamma$=0 indicates that all output deviations are due to factors outside the farmers control ($\sigma_u^2$=0 thus$\sigma^2$= $\sigma_v^2$), when $\gamma$=1 indicates that all deviations are due to technical inefficiency ($\sigma_v^2$=0, thus $\sigma^2$= $\sigma_v^2$,).

The technical efficiency of individual firm can be defined as the ratio of observed or realized (actual output) to the stochastic frontier output (potential output). The stochastic frontier output is the maximum output possible given the technology available and inputs used, it is given by

$$Q_i^* = exp(x_i\beta + V_i) \qquad 4.4$$

Where$U_i$=0 because production is technically efficient on the stochastic frontier.

$$TE_i = \frac{actual\ output}{potential\ output} = \frac{Q_i}{Q_i^*} = \frac{exp(x_i\beta + V_i - U_i)}{exp(x_i\beta + V_i)} = exp(-U_i) \qquad 4.5$$

Where $TE$ is technical efficiency, the inefficiency term $U_i$ is always between 0 and 1, When $U_i$ is equal to zero, then production is on the frontier $Q_i^* = exp(x_i\beta + V_i)$, and $TE$=1, thereforea farmer is technically efficient. When $U_i$ is greater than zero ($U_i$>0) the farmer is technically inefficient ($TE$<1), since production will be below the frontier.

Previously, $TE$ was estimated by using a two-stage process. First, was to measure the level of efficiency/inefficiency using a normal production function. Second, was to determine socio-economic characteristics that determine levels of technical efficiency (Kiraaba, 2005). This was done by using a probit model, with $TE$ as the dependent variable and socio-economic characteristics as independent variables. However since

2000, the stochastic frontier and inefficiency models are jointly estimated by using either Limdep (Green, 2002) or Frontier computing packages which apply MLE (Kiraaba, 2005).

### 4.4 Empirical Specification for Stochastic Frontier and Technical Inefficiency Models

Estimation of technical efficiency involve a stochastic frontier production function specified for cross-sectional data which have an error term which have two components, one account for random effects and another account for technical inefficiency. This model takes into account the weaknesses of deterministic frontier models which do not include random effects and assume that all deviations are due to inefficiency.

#### 4.4.1 Stochastic Frontier Production Function

The stochastic frontier model can take either Cobb-Douglas production function or the Translog production function. The Cobb-Douglas production function imposes restrictions on the farm's technology by assuming constant production elasticities and setting the elasticity of input substitution to unity (Simar and Wilson, 1998).In addition, it assumes a fixed return to scale and a linear relationship between the output and inputs used in production. On the other hand, the Translog production function assumes existence of nonlinear relationship between the output and inputs, and production elasticities are not constant.

The model can be expressed in the general form as,

$$ln(Q_i) = \beta_o + \beta_1 ln(X_{i1}) + \beta_2 ln(X_{i2}) + \beta_3 ln(X_{i3}) + \beta_4 ln(X_{i1})^2 + \beta_5 ln(X_{i2})^2 + \beta_6 ln(X_{i3})^2 + \beta_7 ln(X_{i1}) ln(X_{i2}) + \beta_8 ln(X_{i1}) ln(X_{i3}) + \beta_9 ln(X_{i2}) ln(X_{i3}) + (V_i - U_i) \quad 4.6$$

Where $Q_i$ is the total value of the output in the $i^{th}$ farm produced in the year.

$X_{i1}$ is the farm size in acres cultivated by the $i^{th}$ household in the year ($i = 1,2, \ldots 301$).

$X_{i2}$ is the total number of labour used by the $i^{th}$ household in the year.

$X_{i3}$ is the value of capital in Tshs used by the$i^{th}$ household in a year.

$\beta$'s are unknown parameters of the model. If$\beta_4 = \beta_5 = \cdots = \beta_9 = 0$, this will imply Cobb-Douglas production function.

$V_i$ is the random variable assumed to be independently and identical distribution$N(0, \sigma_v^2)$and independent of $U_i$.

$U_i$ is the random variable that accounts for technical inefficiency and assumed to be independently as truncation of normal distribution with mean $\mu_i$ and variance$\sigma_u^2 \sim N(\mu_i \sigma_u^2)$.

### 4.4.2 The Technical Inefficiency Model

The technical inefficiency model can be specified as either neutral technical inefficiency effects model or non-neutral technical inefficiency effects model, which originally proposed by Huang and Liu (1994). The neutral technical inefficiency model assumes that the change in frontier for different farms is independent of the changes in factor input use and neutral. On the other hand, non-neutral technical inefficiency model implies that shift in the frontier for different farms depend on the level of input use. In addition, elasticities of the mean output for different farms are the function of input variables as well as farm specific variables involved as technical inefficiency explanatory variables.

This study employs the more general non neutral technical inefficiency effects model, which includes input variables used in frontier model (farm size, labour and capital) and farm specific variables assumed to influence the farmer's efficiency.

The inefficiency model is specified as:

$$\mu_i = \alpha_o + \alpha_1 ln(X_1) + \alpha_2 ln(X_2) + \alpha_3 ln(X_3) + \alpha_4 sex + \alpha_5 primary + \alpha_6 secondary + \alpha_7 ext + \alpha_8 crdt + \alpha_9 primary * ext + \alpha_{10} faexp * crdt + \varepsilon_i \quad 4.7$$

Where $\mu_i$ represent technical inefficiency,

$X_1, X_2$ *and* $X_3$ are the factor inputs (farm size, labour and capital) used by the household.

$sex$ represents the gender of the household head (1 for male, 0 for female)

$primary$ is the dummy variable represents the household head's educational level (1 if the highest educational level is standard seven, 0 otherwise.

$secondary$ is the dummy variable represents the household head's educational level (1 if the highest educational level is secondary, 0 otherwise.

$ext$ represents extension services received by the household (farmer).

$crdt$ is the dummy variable measure the access to formal credit by the farmer (1 if accessed formal credit, 0 otherwise)

$faexp$ represents farm experience (in years) of the household head.

Where $primary * ext$ represents interaction between primary education and extension services and $faexp * crdt$ are interactions of farm experience and access to formal credit.

$\alpha' s$are parameters of the model. If$\alpha_1 = \alpha_2 = \alpha_3 = 0$, this will imply neutral technical inefficiency effects model

$\varepsilon_i$is symmetric error term, independently and identical distributed$\sim N(0, \sigma^2)$.

### 4.4.3 Elasticity and Returns to Scale

As far as Translog stochastic frontier production function (equation 4.6) is concern, the estimated coefficients will not have straight forward interpretation. This is because, for a Translog production function, the output elasticities with respect to the inputs are functions of the first order and second order coefficients, together with the level of inputs used. In addition, since the study includes input variables (farm size, labour and capital) in both, the stochastic frontier model (4.6) and inefficiency model (4.7), the output elasticity with respect to the inputs is the function of the value of the inputs in both the frontier and the inefficiency models. Following Battesse and Broca (1997), the elasticity of mean output is decomposed into the frontier elasticity and the elasticity of technical efficiency as follows:

$$\frac{\partial lnE(Y_i)}{\partial lnX_{ji}} = \left\{\beta_j + \beta_{jj} lnX_{ji} + \sum_{j \neq k} \beta_{jk} lnX_{ki}\right\} + C_i \left\{\frac{\partial \mu_i}{\partial X_{ji}}\right\} \qquad 4.8$$

$$\text{Where,} C_i = 1 - {}^{1}\!/_{\sigma} \left\{\frac{\emptyset\left({}^{\mu_i}\!/_{\sigma} - \sigma\right)}{\Phi\left({}^{\mu_i}\!/_{\sigma} - \sigma\right)} - \frac{\emptyset\left({}^{\mu_i}\!/_{\sigma}\right)}{\Phi\left({}^{\mu_i}\!/_{\sigma}\right)}\right\} \qquad 4.9$$

$\mu_i$is defined by model (4.7), ($\emptyset$) and ($\Phi$) are density and distribution functions of the standard normal variables, respectively. The first component of the model (4.8) is referred to the elasticities of frontier output and second part is called elasticity of technical efficiency. The elasticity of technical efficiency is zero for the neutral stochastic frontier model, but non zero for the non-neutral model. The sum total of the output elasticity is the estimated scale elasticity ($\varepsilon$). When ($\varepsilon$) $> 1$, it referred to increasing return to scale (IRS), ($\varepsilon$) $< 1$, implies decreasing return to scale (DRS), whereas, if ($\varepsilon$) $= 1$, referred to constant return to scale (CRS).Stochastic frontier and technical inefficiency models (equation 4.6 and 4.7) are simultaneously estimated by FRONTIER 4.1program.

## 4.5 Empirical Specification for Forest Resources Extraction Model

Forest resources extraction model is used to examine the influence of farming efficiency on forest resources extraction. It is specified as follows:

$$Q_f = \alpha_o + \alpha_1 TE + \alpha_2 sex + \alpha_3 age + \alpha_4 agesq + \alpha_5 primary + \alpha_6 secondary + \alpha_7 hhw + \alpha_8 offinc + \alpha_9 hsize + \alpha_{10} dist + \varepsilon_i \quad 5.0$$

Where

$Q_f$ = Total market value of forest products collected by the household in a year.

$TE$ = estimated farming technical efficiency of the household,

Others are variables reflect household characteristics; sex of the household head, age, primary and secondary education, household wealth, off-farm income and household size. $dist$ represents the distance of the village from the forest.

$\varepsilon$ is error terms of the model.

## 4.6 Hypotheses of the Study

The following hypotheses are tested in this study

1. There is presence of technical inefficiency in agricultural activities among farmers in Kilosa district.
2. Social economic variables affect technical efficiency in agriculture.
3. Technical efficiency in agriculture affects forest conservation.

## 4.7 Choice of Variables and their Measurement

For the dependent variable, information about the output grown by each household was collected. Since majority practiced mixed farming, where different crops (i.e. maize, beans, tomatoes, fruits, etc.) cultivated in the same farmland, it couldn't be possible to combine different kind of farm products in the same unit, thus output was measured in terms of total market values of products harvested by the household in a year. The analysis assumed that the prices of the same products are the same across villages, and the value of each product was obtained by multiplying the price of each product with respective quantity. The market value of all farm products of the household was obtained by adding the value of each product harvested by the household.

Information on inputs used by farmers was collected; the farm size cultivated by the household was measured in acres. For the households who cultivated more than one plot, the size of total farmland was taken by adding up each plot cultivated by the household. The information on whether or not the households irrigate their farmland was collected. This was recorded as dummy variable, 1 for the households using irrigation in at least one of their plots and 0 otherwise.

Labour was measured as the number of household members who participated in farming activities plus the hired labour used in a year. Capital was measured as the total values of farm implements and machinery used by the household in a year (hand hoe, tractor, oxplough, watering can, etc), the quantity of hand hoes was regarded as equivalent to the number of household members engaged in farming during the year and the value of hand hoes used was measures by multiplying the price of a hand hoe with the total number of hand hoes used in a farmland. The age of the hand hoes as well as other farm implements were assumed to be the same. The value of the tractor was measured by the cost of leasing the tractor incurred by the household on a cultivated plot; therefore for those who did not use the tractor during the season under study had a value of zero. The value of other farm implements were taken after multiplying the quantity of the implement with their respective market prices, therefore the total value of capital was obtained by adding up the value of each farm implement used by the household in a year.

Extension service details were asked directly to the households and were recorded as dummy, 1 for the farmers who received extension services and 0 for those did not. Information about social-economic characteristics of farmers; farmer's educational level, age, sex, household size, farm experience, wealth and off-farm income was recorded. Concerning the level of education, primary and secondary dummy variables were included to capture the effect of primary and secondary education in farming efficiency and forest resources extraction. Education below standard seven (primary level) was treated as reference level to avoid a dummy variable trap. The gender of the household head was recorded as a dummy variable, 1 for male and 0 for female household head. Farm experience was measured as the number of years the household cultivated the farmland. For the households who had more than one plot, farm experience was measured as the number of years the household spend on cultivating the largest plot.

Farmers' wealth was measured as the total values of assets owned by the farmer; livestock, poultry, bicycles, radios, television etc. during the year. The market value of the items was given by the households based on what prices they were ready to accept for them to sell the items. The value was taken from the household because they were the ones knew the condition and quality of the items owned.

As the study examines the influence of agricultural activities on forest extraction, information about the value of forest products extraction and land clearing by the villagers during the year of study were recorded. The forest resource extraction was measured by the total market values of forest products collected by the household in a year. Forest products such as fruits, firewood, thatching grass, honey, medicine poles etc. were collected by households. The market values of some of the products were easier to obtain like poles, charcoal, firewood, logs, honey and thatching grass as they are traded at local markets. The values of other products were asked and given directly by the households and village leaders like price of medicines, ropes, forest fruits etc. Information on Land clearing by the household was also recorded; it was measured as the size of the area in acres cleared by the household for crop cultivation during the observed year.

Details about the access of the households to formal credit from financial institutions were also recorded. Households were asked on whether they could have access to formal credit or not. It was measured as dummy variable and recorded as 1 if the household can get credit and 0 otherwise.

## 4.8 Analytical Technique

The study estimated the stochastic frontier and technical inefficiency models simultaneously in one stage process by using FRONTIER 4.1 program. FRONTIER 4.1 program employs Maximum likelihood Estimation (MLE's) which takes into account the inefficiency of various individual farmers. Forest resources extraction model was estimated by using the Ordinary Least Square (OLS) method of estimation.

## 4.9 Conclusion

The methodology presented in this chapter was used in determining the influence of technical efficiency in agriculture on forest conservation. The study conducted in Kilosa District which constitutes villages located along the forest peripheries and practicing farming and forest extraction activities.

# CHAPTER FIVE

# EMPIRICAL RESULTS AND THEIR INTERPRETATIONS

## 5.0 Introduction

This chapter presents and discusses the results as per the methodology outlined in chapter four. Section one presents descriptive statistics of the study, section two discusses the results and interpretation of the frontier and forest extraction models, and lastly, section three which verify the hypothesis of the study.

## 5.1 Descriptive Analysis

Definition and descriptive statistics of the variables used in estimation of stochastic frontier production function and forest extraction models in Kilosa district are presented in Table 5.1 and Table 5.2.From Table 5.2, about 77 percent of the household sampled were male headed, whereas 23 percent were female headed, with an average household size of 4.3 persons.

More than 96 percent of the household interviewed depended on agriculture as the main economic activity, while less than 4 percent depended on mining, labour employment, own businesses and other activities. The average farm size cultivated by the household was 3.2 acres with majority cultivated between 2.0 to 3.9 acres (see Figure A2 in Appendix). Only 7 percent of the households had cleared new land for crop cultivation during the year the study conducted.

**Table 5.1: Definition of the Variables used in the Analysis**

| Variable | Description |
|---|---|
| **qi** | Total value of output produced by a household in a year |
| **fsize** | Farm size |
| **l** | labour (family and hired labour) |
| **k** | The value of equipments and machinery used in the farm |
| **age** | Age of the household head |
| **sex** | Sex of the household head (1 for male, 0 for female) |
| **faexp** | Farm experience of the household head |
| **Primary** | Primary as the highest level of education |
| **Secondary** | Secondary as the highest level of education |
| **ext** | Extension service |
| **irr** | Irrigation |
| **crdt** | Formal credit |
| **Qf** | Total value of products collected from the forest |
| **Ac** | Area cleared by the household in the past 1 year. |
| **offinc** | Off-farm income |
| **hhw** | Total value of household wealth |
| **hsize** | Household size |
| **dist** | Distance of the village from the forest |

Further, agricultural activities undertaken were mainly subsistence and depended heavily on climatic condition. Only 6 percent of the households indicated to have irrigation in at least one of their plots during cropping seasons. Application of farm inputs was low, majority used hand hoe, with 20 percent using tractor, less than 1 percent using ox-plough and no one used fertilizers. Similarly, access to formal credits by farmers was very low, about 82 percent of the households interviewed indicated that they had no access to any formal credits from financial institutions.

**Table 5.2: Descriptive Statistics**

| Variable | Units | Obs. | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|---|
| **Output** | Tshs. | 300 | 556184.3 | 796031.8 | 16250 | 9489000 |
| **Farm size** | Acres | 300 | 3.23 | 2.39 | 0.3 | 16 |
| **Labour** | Numbers | 300 | 3.53 | 1.81 | 1 | 12 |
| **Capital** | Tshs. | 300 | 50886.67 | 92232.8 | 5000 | 700000 |
| **Age** | Years | 301 | 46.91 | 15.19 | 18 | 95 |
| **Sex** | 1 or 0 | 301 | 0.77 | 0.42 | 0 | 1 |
| **Primary** | 1 or 0 | 301 | 0.60 | 0.49 | 0 | 1 |
| **Secondary** | 1 or 0 | 301 | 0.07 | 0.25 | 0 | 1 |
| **Farm experience** | Years | 298 | 13.39 | 12.93 | 1 | 70 |
| **Extension service** | 1 or 0 | 299 | 0.54 | 0.5 | 0 | 1 |
| **Irrigation** | 1 or 0 | 299 | 0.06 | 0.24 | 0 | 1 |
| **Credit** | 1 or 0 | 300 | 0.17 | 0.38 | 0 | 1 |
| **Forest extraction** | Tshs. | 300 | 169340.7 | 326275.5 | 0 | 5290000 |
| **Land clearing** | Acres | 20 | 1.98 | 0.9 | 0.5 | 3.5 |
| **Off-farm income** | Tshs. | 217 | 256559.9 | 759270.9 | 0 | 9360000 |
| **Forest experience** | Years | 299 | 31.65 | 17.93 | 1 | 87 |
| **Household wealth** | Tshs. | 286 | 312218.5 | 446051.9 | 6000 | 2786000 |
| **Household size** | Numbers | 301 | 4.31 | 1.83 | 1 | 13 |
| **Distance** | Km | 301 | 5.42 | 3.07 | 0.5 | 12 |

Source: Author’s computation (2013)

With regard to level of education, more than 33 percent of the household heads had education below standard seven (see Table 5.3), with about 60 percent having completed primary school (standard seven), and less than 7 percent completed secondary education. There was no household head having tertiary level of education in the sample interviewed.

**Table 5. 3: Educational Level of the Household Heads**

| Education level | Number of household heads | Percentage |
|---|---|---|
| Below std 4 | 64 | 21.3 |
| Standard 4 | 37 | 12.3 |
| Primary | 180 | 59.8 |
| Secondary | 20 | 6.6 |
| Tertiary | 0 | 0.0 |
| Total | 301 | 100.0 |

Source: Author's computation (2013)

Concerning household wealth, about 96 percent households had wealth, ranging from Tshs 6000 to Tshs 2.8 million, of which 27 percent had wealth below Tshs 100,000, about 86 percent had less than Tshs. 500,000 wealth, while only 6.6 percent of the households had wealth of above Tshs 1 million (Table5.4).

**Table 5.4: Household Wealth (in Tshs)**

| Household wealth (Tshs.) | Percentage of households |
|---|---|
| <100,000 | 26.6 |
| 100,000-499,000 | 59.8 |
| 500,000-1mil | 7.0 |
| Above 1 mil | 6.6 |
| Total | 100.0 |

Source: Author’s computation (2013)

Majority of households indicated to own at least a bicycle, radio, poultry (chicken) and mobile phone. About 54 percent of the households had at least one member engaging in other income generating activities apart from agriculture. Majority were operating businesses activities like selling liquor (mostly done by women), retail shops, carpentry and transportation services (i.e. *Bodaboda*). Some households obtained income from selling their labour on other people's farms, while minority earned income from employment and pension.

Lastly, household use of forest products revealed that majority of the households collected products from the forest due to their proximity to the natural resources collected. The most common forest product collected by the households was firewood, followed by building materials (poles, logs, thatching grass, palm leaves and ropes), food products (mushroom, wild meat, honey), charcoal and medicine.

### 5.2 Results and Interpretation

This section presents econometrics results of two models, discussed in chapter four i.e. stochastic frontier production function and forest resources extraction models. Stochastic frontier production function estimates farmers' technical efficiency and associated factors which influence variation in technical efficiencies among farmers. In this estimates, farmer who had output valued above Tshs. 8 million was dropped as outlier because the value is dispersed far from other observations (see Figure A3 in Appendix).

Estimated technical efficiencies scores obtained were then included in the forest resources extraction model. The forest resources extraction model was used to determine the influence of technical efficiency in agriculture on forest resources extraction among households in Kilosa district.

### 5.2.1 Results and Discussion of the Stochastic Frontier Production Model

#### 5.2.1.1 Correlation Analysis and Heteroscedasticity Test

Before the estimates conducted, correlation analysis of the variables in stochastic frontier model and forest extraction models was examined. The correlation analysis is performed to detect the linear dependence relationship between the variables used in our models. The results in Table 5.5show that, the variables seems to have less linearly dependent to each other, which confirms that correlation is not a serious problem in our variables.

The stochastic frontier model is then regressed by using OLS (the results are not shown) so as to perform Heteroscedasticity test. Heteroscedasticity is mostly prevalent in survey data like the study uses, it occurs when the violation of one of the requirements of Ordinary Least square (OLS) that the error variance is not constant across observations. It is caused by; the variance of dependent variables increases with the increase in level of dependent variable, variance of dependent variable increases or decreases with changes of independent variables and presence of outliers in the data set. The consequence of Heteroscedasticity is that, the estimated coefficients are inefficient though they are unbiased. The presence of Heteroscedasticity causes variance to be too small or too high, leading to type I or type II errors. The study uses Breusch-Pagan/Cook-Weisberg test for Heteroscedasticity which test the null hypotheses Ho, that there is no Heteroscedasticity (constant variance).

| Variables | Output | Farm size | Labour | Capital | Sex | Primary | Secondary | Farm experience | Extension contact | Credit | Ln(forest extraction) | Technical efficiency | Age | Age^2 | Ln(hh wealth) | Ln(Off-farm income) | Household size | Distance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | 1.000 | | | | | | | | | | | | | | | | | |
| **Farm size** | 0.388 | 1.000 | | | | | | | | | | | | | | | | |
| **Labour** | 0.288 | 0.442 | 1.000 | | | | | | | | | | | | | | | |
| **Capital** | 0.384 | 0.377 | 0.398 | 1.000 | | | | | | | | | | | | | | |
| **Sex** | 0.128 | 0.117 | -0.015 | 0.103 | 1.000 | | | | | | | | | | | | | |
| **Primary** | 0.024 | 0.101 | 0.120 | 0.107 | 0.076 | 1.000 | | | | | | | | | | | | |
| **Secondary** | 0.072 | -0.022 | 0.052 | 0.058 | 0.017 | -0.325 | 1.000 | | | | | | | | | | | |
| **Farm experience** | 0.109 | 0.272 | 0.094 | -0.030 | 0.003 | -0.190 | -0.045 | 1.000 | | | | | | | | | | |
| **Extension contact** | -0.073 | 0.045 | -0.034 | -0.076 | 0.078 | 0.058 | -0.032 | -0.029 | 1.000 | | | | | | | | | |
| **Credit** | 0.221 | 0.236 | 0.199 | 0.139 | 0.059 | 0.107 | 0.231 | -0.015 | -0.111 | 1.000 | | | | | | | | |
| **Ln(forest extraction)** | -0.011 | 0.055 | 0.213 | 0.064 | 0.013 | 0.120 | -0.018 | -0.102 | -0.250 | 0.069 | 1.000 | | | | | | | |
| **Technical efficiency** | 0.440 | -0.206 | -0.280 | 0.006 | -0.031 | 0.033 | 0.054 | 0.013 | 0.062 | 0.142 | -0.175 | 1.000 | | | | | | |
| **Age** | -0.048 | 0.105 | 0.073 | -0.090 | -0.021 | -0.452 | -0.042 | 0.457 | -0.108 | -0.037 | 0.066 | -0.135 | 1.000 | | | | | |
| **Age^2** | -0.056 | 0.087 | 0.035 | -0.111 | -0.026 | -0.477 | -0.037 | 0.474 | -0.098 | -0.062 | 0.019 | -0.120 | 0.983 | 1.000 | | | | |
| **Ln(hh wealth)** | 0.349 | 0.383 | 0.314 | 0.328 | 0.226 | 0.133 | 0.058 | 0.140 | -0.046 | 0.276 | 0.123 | -0.013 | 0.021 | -0.025 | 1.000 | | | |
| **Ln(Off-farm income)** | 0.250 | 0.132 | 0.176 | 0.241 | -0.064 | 0.077 | 0.239 | -0.091 | -0.148 | 0.270 | 0.025 | 0.075 | -0.077 | -0.075 | 0.301 | 1.000 | | |
| **Household size** | 0.100 | 0.188 | 0.317 | 0.095 | 0.145 | 0.081 | 0.035 | 0.027 | -0.087 | 0.128 | 0.526 | -0.158 | 0.032 | -0.011 | 0.253 | 0.049 | 1.000 | |
| **Distance** | -0.059 | 0.045 | -0.020 | -0.189 | 0.045 | -0.027 | -0.021 | 0.195 | 0.043 | -0.179 | -0.165 | -0.236 | 0.030 | 0.053 | 0.042 | -0.114 | 0.093 | 1.000 |

**Table 5. 5: Correlation analysis**

The results below show that the probability of, computed chi-square to be less than critical value is more than 39 percent, and the presence of Heteroscedasticity is not significant even at 10 percent, therefore, the test fail to reject the null hypothesis that there is constant variance hence the study concludes that there is no Heteroscedasticity.

**Figure 5.1: Heteroscedasticity Test**

```
Breusch-Pagan / Cook-Weisberg test for Heteroscedasticity
Ho: Constant variance
         Variables: fitted values of lnqi
         chi2 (1)      =     0.72
         Prob. > chi 2 =   0.3965
```

**Source**: Author's computation, 2013

The study then performs model specification tests in order to examine the significance of the model specified and the relevance of variables in inefficiency function. The tests are examined by using the generalized likelihood ratio statistics (LR) which is given by $LR = -2[ln\{L(H_o)\} - ln\{L(H_1)\}]$, where $L(H_o)$ and $L(H_1)$ are values of likelihood function under the null ($Ho$) and alternative ($H_1$) hypotheses, respectively. LR has approximately a Chi-square/mixed Chi-square distribution. The calculated likelihood ratio statistics (LR) is then compared with the critical Chi-square value from the Chi-square table, corresponding to the degree of freedom which is equal to the number of parameters assumed to be zero in null hypothesis.

From Table 5.6, tests were performed separately under neutral and non-neutral model specification. The first hypothesis, tests the absence of inefficiency effects, it is strongly rejected in both neutral and non-neutral models. It confirms the presence of one sided error component in the model, thus rendering the use of ordinary least square (OLS) inadequate in representing the data. The second hypothesis tests whether Cobb-Douglas production function is the appropriate model for the analysis, is rejected irrespective of whether neutral or non-neutral model specification is used, thus the test implies that Translog production function is adequate in representing the data. Further, the hypothesis that all parameters in inefficiency function are zero is accepted in neutral model specification, suggesting that all parameters used in inefficiency model are not significantly different from zero; however the hypothesis is rejected in non-neutral model specification. Thus, the decision of whether or not to include inefficiency variables depends on the last test which investigates if neutral or non-neutral model specification is adequate representing the data. The last hypothesis is strongly rejected, which suggests that the more general non neutral Translog production frontier model is adequately representing the data.

**Table 5. 6: Model Specification Tests**

| Null Hypothesis | log-likelihood | LR Statistics | Critical $\chi^2$ | Decision |
|---|---|---|---|---|
| **Neutral model specification** | | | | |
| Test 1 $Ho$: $\gamma = 0$ | | | | |
| | -443.31 | 175.42 | 5.14 | Reject Ho |
| Test 2 $Ho$:$\beta_4 = \beta_5 = \cdots = \beta_9 = 0$ (Cobb-Douglas) | | | | |
| | -370.86 | 30.52 | 12.59 | Reject Ho |
| Test 3: $Ho$: $\delta_4 = \delta_5 = \cdots = \delta_{10}$ (No tech inefficiency function) | | | | |
| | -360.51 | 9.81 | 14.07 | Accept Ho |
| **Non neutral model specification** | | | | |
| Test 1:$Ho$: $\gamma = 0$ | | | | |
| | -443.31 | 192.49 | 5.14 | Reject Ho |
| Test 2: $Ho$:$\beta_4 = \beta_5 = \cdots = \beta_9 = 0$ (Cobb-Douglas) | | | | |
| | -359.46 | 24.79 | 12.59 | Reject Ho |
| Test 3: $Ho$: $\delta_4 = \delta_5 = \cdots = \delta_{10}$ (No tech inefficiency function) | | | | |
| | -360.30 | 26.47 | 14.07 | Reject Ho |
| **Neutral Vs Non neutral model** | | | | |
| Test 4: $Ho$: $\delta_1 = \delta_2 = \delta_3 = 0$ | | | | |
| | -355.60 | 17.07 | 7.81 | Reject Ho |

Mixed $\chi^2$ values are taken from Kodde and Palm (1986)

### 5.2.1.2 Interpretation of the Results

The results of Translog production frontier model are presented in Table 5.7. The results show that the diagnostic statistics of the model indicates that the gamma ($\gamma$) coefficient is 0.95 and statistically significant at 1 percent level. It is close to 1, thus assuring the stochastic nature of the production function. It implies that about 95 percent of variation in the output level among the farmers in Kilosa district is attributed to technical inefficiency effects. The coefficient of sigma square ($\delta^2$) is 6.30 and significant at 1 percent level, which indicating the correctness of specified assumption of distribution of composite error term.

The results show that only capital input found to have expected positive sign consistent with the theory of production, whereas, farm size and labour have unexpected negative signs. The possible reasons for the negative signs are; majority of farmers use hand hoes thus unable to cultivate large farm sizes, as the results output decreases as farm size increases. Likewise for labour usage, the mean farm size may be subject to labour congestion, thus further increase in labour lead the decrease in output level. However, estimated input coefficients in the Translog frontier production function presented in Table 5.7 do not have straightforward interpretations. Thus, it is necessary to estimate the output elasticity for each of the inputs used in order to have meaningful interpretation (Awudu and Eberlin, 2001; Hepelwa, 2011).

#### 5.2.1.3 Interpretation of the Parameters of Inefficiency Model

The parameters in the inefficiency model are interpreted as the change in inefficiency with respect to change in the variable. The model specified inefficiency as the dependent variable; hence the negative sign indicates decrease in inefficiency (increase in efficiency). The results presented in Table 5.7 shows that most of the parameters in inefficiency model are statistically significant explaining farming inefficiency.

**Table 5. 7: Results from Translog Stochastic Frontier Production Function**

| Variable | Parameters | Coefficient | t-ratio |
|---|---|---|---|
| Constant | $\beta_o$ | 0.51 | 0.57 |
| Ln(farm size) | $\beta_1$ | -0.65 | -0.87 |
| Ln(Labour) | $\beta_2$ | -0.83 | -0.93 |
| Ln(capital) | $\beta_3$ | 2.34*** | 10.50 |
| Ln(farm size)* ln(farm size) | $\beta_4$ | -0.01 | -0.07 |
| Ln(labour) * ln(labour) | $\beta_5$ | 0.37 | 1.64 |
| Ln(capital)*ln(capital) | $\beta_6$ | -0.11*** | -7.80 |
| Ln(farm size)*ln(labour) | $\beta_7$ | -0.52*** | -2.69 |
| Ln(farm size)*ln(capital) | $\beta_8$ | 0.18** | 2.31 |
| Ln(capital)*ln(labour) | $\beta_9$ | 0.06 | 0.55 |
| | | | |
| Variance parameters | | | |
| Sigma-square | $\delta^2$ | 6.30*** | 5.28 |
| gamma | $\gamma$ | 0.95*** | 71.14 |
| | | | |
| Constant | $\delta_o$ | -3.72* | -1.94 |
| Ln(farm size) | $\delta_1$ | 1.98*** | 5.94 |
| Ln(Labour) | $\delta_2$ | 6.19*** | 10.48 |
| Ln(capital) | $\delta_3$ | -1.77*** | -13.57 |
| Sex | $\delta_4$ | 2.57*** | 3.55 |
| Primary | $\delta_5$ | 5.57*** | 8.47 |
| Secondary | $\delta_6$ | -1.51 | -1.46 |
| Extension services | $\delta_7$ | -0.76 | -0.55 |
| Credits | $\delta_8$ | -3.70*** | -4.48 |
| Primary*extension services | $\delta_9$ | -3.85*** | -3.94 |
| Farm experience*credits | $\delta_{10}$ | -0.07*** | -2.69 |
| Likelihood function | | -347.06 | |
| Mean efficiency | | 0.64 | |

Note: *** significant at 1 percent, ** significant at 5 percent, * significant at 10 percent level.
**Source**: Results from FRONTIER 4.1

The results show that the size of the farmland is significantly affects efficiency of the farmer; increase in the size of the farm reduces farming efficiency. The possible reason is that, majority of farmers in Kilosa district use traditional and inferior farming inputs like hand hoes, hence become inefficient whenever they cultivate large farmlands.

Likewise, the results indicate that increase in number of labour significantly reduces farming efficiency. However, increase in capital indicated to increase efficiency of the farmers (reduce inefficiency). This is due to the fact that farming implements and equipment like tractor enable the farmer to cultivate large plot of land, as the result more output harvested.

Gender of the farmer indicated to influence farming efficiency, the sex parameter has unexpected positive sign and significant at 1 percent level, implying that being a male farmer increases inefficiency (reduces efficiency) in cultivation. The possible reason of this result may be due to the sample size interviewed which comprised more male headed households than female headed, thus male heads households who were less efficient may outweigh those who were more efficient.

Education also seems to affect farming efficiency level. The results indicate that primary education significantly reduces farming efficiency. While secondary education improves efficiency though is not statistically significant. The result also show that access to formal credits is significantly increases the level of farming efficiency.

To explore the results further the study examined interaction between variables influencing efficiency by combining primary education and extension services, as well as farm experience and access to formal credit. The results show that the coefficient of interaction between primary education and extension services is negative and statistically significant at 1 percent, implying that, to the farmers who have primary level of education, farming efficiency may be improved by providing them with extension services. Likewise, the coefficient of farm experience and access to formal credit shown to be negative and significant at 1 percent, suggests that, farming efficiency may be improved if experienced farmers have access to formal credits.

#### 5.2.1.4 Interpretation of Input Elasticity and Returns to Scale

The elasticity of mean frontier output with respect to the $j^{th}$ input variable has two components: (i) the elasticity of frontier output with respect to the $j^{th}$ input, given by the estimated $\beta_j$parameters and (ii) the elasticity of TE with respect to the $j^{th}$ input. Elasticities of mean output with respect to the input variables (farm size, labour and capital) are estimated by using equation (4.8). In this equation, the respective mean values presented in Table (5.2) and coefficients parameters from Table (5.7) are used to estimate elasticities. The results of input elasticity and returns to scale are summarised in Table 5.8.

**Table 5.8: Elasticity Parameter Estimates with respect to all Inputs**

| Variable | Frontier Output elasticity | Technical efficiency elasticity |
|---|---|---|
| Farm size | 0.008 (0.870) | 1.677 (0.334) |
| Labour | -0.355 (1.107) | 5.230 (0.590) |
| Capital | 1.261 (0.285) | -1.499 (0.131) |
| **Returns to scale** | **0.914 (1.436)** | **5.407 (0.691)** |

**Note:** Figures in the parenthesis are standard errors
**Source**: Author's computation (2013)

The results in Table 5.8indicate that, for the frontier output elasticity the coefficients of farm size and capital have positive signs, whereas, labour coefficient has negative sign. In technical efficiency elasticity, farm size and labour have positive signs, while capital has negative sign. Further, only capital coefficient is significant for the frontier output elasticity while in technical efficiency elasticity, all input coefficients found to be statistically significant at 1 percent level.

Specifically, the results indicate that the capital input has the highest frontier output elasticity of 1.261, and statistically significant at 1 percent, implies that, 1 percent increase in capital usage, increases output level by 1.26 percent, other factors remain constant. This suggests the high responses of harvests with respect to the capital usage and suggests that, the uses of farm implements and machinery in cultivation enable the farmer to cultivate large plot of land as a results, more output is harvested.

Farm size and labour coefficients found to be positive and statistically significant for the technical efficiency elasticity, with labour coefficient being the highest elasticity. It implies that farm technical inefficiency increases with the increase in farm size and labour usage. The possible reason is; majority of farmers in Kilosa district use hand hoes which may not be able to utilise large farmlands efficiently, also the mean farm size may be subject to labour congestion, thus lead inefficiency increases with the increase in labour usage.

The coefficient of capital input for TE elasticity is negative and statistically significant at one percent, indicating that farming technical efficiency increases (inefficiency decreases) with the increase in capital usage.

Lastly, the estimated returns to scale are 0.914 and 5.407 for frontier output elasticity and TE elasticity, respectively; though is significant only for TE elasticity. It is greater than 1 ($\varepsilon > 1$) implying increasing returns to scale (IRS). This may be attributed by little capital usage by farmers and suggesting that the farming inefficiency may be reduced by increasing the usage of capital input.

The distribution of technical efficiency by villages and among household farmers in Kilosa district is presented in Table 5.9, with Nyali, Chabima and Dodoma Isanga villages under REDD project, while Changarawe and Mamoyo are outside the project.

The results show that, overall mean technical efficiency is 0.64 which indicates that farmers still have room to improve their farming efficiency by 0.36. In addition, the mean technical efficiency at village level was the same for Chabima and Dodoma

Isanga, which is 0.65, while Nyali, Changarawe and Mamoyo were 0.64, 0.67 and 0.55 respectively. Changarawe village had the highest mean technical efficiency compared to other villages, however, with regard to technical efficiency ranges, the highest and lowest technical efficient farmers found in Mamoyo village. Further, majority of household farmers in Nyali, Chabima and Dodoma Isanga villages had efficiency ranges from 0.70 to 0.79, while in Changarawe and Mamoyo ranges from 0.60 to 0.69. Few farmers found to have efficiency of less than 0.5 while there was no farmer who had technical efficiency above 0.9 (see Figure A4 in Appendix). The standard deviation indicates that dispersion across and within villages was not a problem, villages were relative similar as the standard deviation was less than 25 percent.

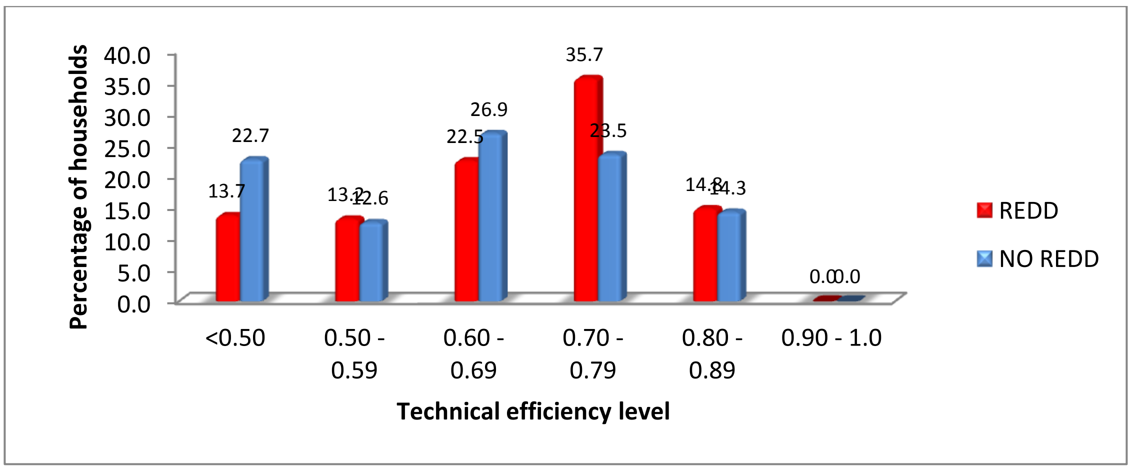
**Table 5. 9: Distribution of Technical Efficiency by Villages and among Household Farmers in Kilosa District**

| **Village** | **Nyali** | | **Chabima** | | **Dodoma Isanga** | | **Changarawe** | | **Mamoyo** | |
|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency class | No of hh | % | No of hh | % | No of hh | % | No of hh | % | No of hh | % |
| <0.50 | 10 | 16.4 | 9 | 14.8 | 6 | 10.0 | 10 | 14.7 | 17 | 33.3 |
| 0.50 - 0.59 | 5 | 8.2 | 8 | 13.1 | 11 | 18.3 | 5 | 7.4 | 10 | 19.6 |
| 0.60 - 0.69 | 13 | 21.3 | 14 | 23.0 | 14 | 23.3 | 21 | 30.9 | 11 | 21.6 |
| 0.70 - 0.79 | 22 | 36.1 | 19 | 31.1 | 24 | 40.0 | 20 | 29.4 | 8 | 15.7 |
| 0.80 - 0.89 | 11 | 18.0 | 11 | 18.0 | 5 | 8.3 | 12 | 17.6 | 5 | 9.8 |
| 0.90 - 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Total | 61 | 100 | 61 | 100 | 60 | 100 | 68 | 100 | 51 | 100 |
| Mean te 0.64 | | 0.64 | | 0.65 | | 0.65 | | 0.67 | | 0.55 |
| Std dev. 0.17 | | 0.19 | | 0.16 | | 0.12 | | 0.16 | | 0.21 |
| Min 0.00 | | 0.08 | | 0.19 | | 0.23 | | 0.05 | | 0.00 |
| Max 0.88 | | 0.87 | | 0.86 | | 0.82 | | 0.86 | | 0.88 |

**Source**: Derived from output of FRONTIER 4.1 program
Note: hh represents households, % represents percentage of households

The study also analyses the contribution of REDD project in improving farming efficiency among household farmers in Kilosa district. This is done by grouping together villages under REDD project and compare their efficiency distribution with those villages were REDD project is not operating. Figure 5.2 summarizes the results.

**Figure 5.2: Comparison of Distribution of Technical Efficiency between Farmers within versus without REDD Project**




**Source**: Derived from output of FRONTIER 4.1 program

From Figure 5.2, the results show that at lower level of technical efficiency, the percentage of household farmers from villages outside the REDD project exceed the percentage of household farmers from the villages under REDD project, specifically, technical efficiency below 0.50, only 14 percent households came from REDD villages compared to 23 percent households from no REDD villages. The efficiency class of 0.50-0.59 have percentage of households which is slightly similar (both had 13 percent), while class of 0.60-0.69, like other lower classes, no REDD villages had larger number of farmers than REDD villages. However, above 0.70 technical efficiency, the number of farmers from REDD villages seem to be higher than no REDD villages. This may imply that training in modern farming techniques, extension services and other agricultural related services provided under the REDD project could have resulted in improving technical efficiency in crop cultivation by majority of farmers.

### 5.2.2 Forest Resources Extraction Model

This section estimates forest resources extraction model, which includes technical efficiency estimates, obtained from FRONTIER 4.1 in the previous section. The model includes other variables as guided by theory in the model estimation. Many of the variables used in estimation were transformed into natural logarithms prior to estimation so as to minimize noise in the data and ease in interpretation. Heteroscedasticity test is performed before the analysis.

#### 5.2.2.1 Heteroscedasticity Test

The study regress forest extraction model by OLS (results is not presented) so as to perform Heteroscedasticity test. The results (Figure 5.3) indicate that, the null hypothesis that, there is constant variance is rejected in favour of the presence of Heteroscedasticity, and it is significant at 1 percent level. Thus the test concludes the presence of Heteroscedasticity. To correct Heteroscedasticity problem, the model is regressed again by OLS with robust standard errors that correct for Heteroscedasticity.

**Figure 5.3: HeteroscedasticityTest**

```
Breusch-Pagan / Cook-Weisberg test for Heteroscedasticity
                 Ho: Constant variance
            Variables: fitted values of lnqf

               chi2 (1)      =     7.92
                Prob. > chi2 =   0.0049
```

**Source**: Author's computation, 2013

### Endogeneity Test

Further, Endogeneity test is performed in forest extraction model to check on whether Endogeneity problem exist. In this model, off-farm income and household wealth are variables likely to cause Endogeneity problem. The Hausman test is used and the results are presented in figure 5.4.

**Figure 5. 4: Endogeneity Test**

```
 (1)  V_hat = 0

F (1,   145) =    0.01

 Prob.> F =    0.9381
```

**Source**: Author's computation, 2013

The results show that the coefficient of the error term (v_hat)[2] is not significantly influencing the dependent variable (forest extraction), which suggests that, Endogeneity problem does not exist in forest extraction model.

[2]The error term (v_hat) is extracted by taking the variable likely to cause Endogeneity problem as the dependent variable of the model.

### 5.2.2.2 Results and Discussion

Table 5.11 summarizes the results obtained from OLS estimations. The second column presents the results when off-farm income is included in the model, whereas, the third column shows the results after off-farm income variable is excluded from the model.

The results in the second column indicate that, analysis includes only 156 observations, 48 percent of households are excluded from the analysis due to missing values of some of explanatory variables. The Prob. > F = 0.0000, implying that the overall fit of the regression is very good and it is significant at 1 percent level. The R-square is 0.3804 indicating that, about 38 percent of variation in forest extraction variable is explained by explanatory variables included in the model. The results also show that technical efficiency, sex, primary education, household size and distance variables are statistically significant at 5 and 1 percent level.

The results in the third column show that, after excluding off-farm income variable, the number of observations increases up to 285, thus 95 percent of the households have included in the analysis. The overall fit of the regression is good and it is significant at 1 percent level. The R-square is 0.3546 indicating that, about 35 percent of variation in forest extraction is explained by explanatory variables. In addition, the technical efficiency, age, primary education, household size and distance coefficients are significant at 5 and 1 level respectively in the third column.

**Model Specification Test**

Model specification test on whether to include or exclude off-farm income variable is performed based on the F test approach in which the calculated F is compared with the critical F in the F-statistical table. F value is calculated by the given formula below;

$$F = \frac{(R_{new}^2 - R_{old}^2)/df_1}{(1 - R_{new}^2)/df_2}$$

Where $R_{old}^2$ is the R-squared before including particular variable(s),$R_{new}^2$ is the R-squared after including variable(s), $df_1$ is the number of regressors after including variable(s), $df_2$ is the number of observations minus number of parameters in the new model. From the formula above, F calculated value is 6.0793, whereas F critical value is 3.92, since F calculated > F critical, then results suggests that inclusion of off-farm income is significantly increases explanatory power of the model, hence interpretation and discussion of the results is based on the second column (off-farm income is included).

**5.2.2.3 Interpretation of the Results in Forest Extraction Model**

The results from Table 5.10 show that, the coefficient of technical efficiency is -0.763. Implying that, if the farming technical efficiency improved by 0.1 then extraction of forest resources will be reduced by 0.8 percent, holding other factors constant. The negative relationship between farming efficiency and forest extractions indicate that, generally, efficient farmers extract fewer products from the forest. The reason for this result is that, households adjacent to the forest depend mainly on farming and forest products for subsistence and income generation, thus inefficiency in farming activities reduces farm output and incomes, thus increases dependence on forest extraction.

Sex variable indicated to have unexpected negative sign and statistically significant at 5 percent. The coefficient of -0.208 implies that, being a male-headed household, reduces extracting forest resources by 0.2 percent, holding other factors constant. The possible reason for this result is that, men and women collect different products for different uses, usually female collect firewood, medicine and food products, while collection of building material products is exclusively a man’s activity, thus the influence of gender on extraction of forest resources is mainly depends on the type of forest product mostly extracted by the households. This study found that firewood was the major product collected by the households, and thus the reason why female headed households shown to collect more forest products than male headed households.

Primary education coefficient indicated to have positive sign and statistically significant. The coefficient of 0.231 implies that, if a person has only primary level of education, extracting forest resources increases by 0.2 percent, other factors held constant. The possible reason is that primary education may only enable a person to recognize that the uses of forest products is more beneficial, without realizing the environmental impacts that may associate with over exploitation of such resources.

**Table 5.10: Results for the Forest Extraction Model**

| | OLS_Robust (1) | OLS_Robust (2) |
|---|---|---|
| **Variable** | **Coefficient** | **Coefficient** |
| Technical efficiency | -0.763** | -0.513** |
| | (0.366) | (0.232) |
| Sex | -0.208** | -0.106 |
| | (0.102) | (0.068) |
| Age | 0.025 | 0.019** |
| | (0.021) | (0.010) |
| Age^2 | -0.0002 | -0.0001 |
| | (0.000) | (0.000) |
| Primary | 0.231** | 0.172** |
| | (0.101) | (0.074) |
| Secondary | -0.016 | 0.043 |
| | (0.204) | (0.153) |
| Ln(household wealth) | -0.005 | -0.006 |
| | (0.042) | (0.028) |
| Ln(off-farm income) | -0.001 | |
| | (0.031) | |
| Household size | 0.158*** | 0.163*** |
| | (0.027) | (0.019) |
| Distance | -0.063*** | -0.049*** |
| | (0.020) | (0.011) |
| Constant | 11.273*** | 11.144*** |
| | (0.554) | (0.390) |
| Number of observation | 156 | 285 |
| Prob.> F | 0.0000 | 0.0000 |
| R-squared | 0.3804 | 0.3546 |

Notes: Figures in the parenthesis are standard errors ***, **, * are P<0.005, P<0.05 and p<0.1 respectively. Model (1) includes off farm income whereas model (2) exclude off farm income.
**Source**: Author's computation, 2013

Household size shows expected positive sign and statistically significant at 1 percent level. The coefficient of household size is 0.158, implying that, holding other factors constant, 1 additional member of the household increases forest resources extraction by 0.2 percent. The reason of positive relationship with forest extraction is that, concerning on the subsistence nature of these households, the major source of energy is firewood, in which the amount consumed depends on the size of the family. In addition, it is easier for a bigger household to allocate part of the household members in agriculture and the rest in forest dependant activities rather than small households, thus leads bigger households likely to consume more forest products than smaller households.

Lastly, the results indicate that the distance of the village from the forest has negative influence on forest resources extraction. The distance coefficient of -0.063 implies that, extraction of forest resources is reduced by 0.06 percent if the village is located 1 kilometre far from the forest, other factors remain constant. The reason is that, generally households live closely to the forest consume more forest products than distant villages because of plentiful of the products around the village. Distant villages have high opportunity cost in terms of distance and time spent, thus consume less forest products.

The study further estimated the model controlling for villages under REDD and those that were not included in the REDD project. The underlying aim was to observe differences in technical efficiencies that the study postulated to exist between the two categories (i.e. REDD and no REDD). The result is summarized in Table 5.11.

The results in Table 5.11 indicate that, technical efficient seems to be significant only in villages under REDD project, the possible reason for this results may be that; in NO

REDD villages there is higher standard errors of technical efficiencies among farmers than in REDD villages, this might contributed to insignificant results.

**Table 5.11: REDD versus NO REDD**

| | REDD | NO REDD |
|---|---|---|
| **Variable** | **Coefficient** | **Coefficient** |
| Technical efficiency | -0.562** | -0.546 |
| | (0.2683) | (0.395) |
| Sex | -0.001 | -0.141 |
| | (0.084) | (0.094) |
| Age | 0.012 | 0.037** |
| | (0.013) | (0.015) |
| Age^2 | 0.000 | -0.0003* |
| | (0.000) | (0.0001) |
| Primary | 0.065 | 0.276** |
| | (0.078) | (0.138) |
| Secondary | -0.028 | 0.064 |
| | (0.183) | (0.258) |
| Ln(household wealth) | -0.008 | -0.058 |
| | (0.029) | (0.054) |
| Household size | 0.183*** | 0.126*** |
| | (0.023) | (0.032) |
| Distance | -0.110 | -0.068*** |
| | (0.080) | (0.015) |
| Constant | 11.492*** | 11.772*** |
| | (0.541) | (0.768) |
| Number of observation | 171 | 114 |
| Prob.> F | 0.0000 | 0.0000 |
| R-squared | 0.4215 | 0.4112 |

Note: Figures in the parenthesis are standard errors ***, **, * are P<0.005, P<0.05 and p<0.1 respectively
**Source**: Author's computation, 2013

The influence of age in extraction of forest resources seems to matter in no REDD villages only, as the coefficient of age and age square shown to be significant at 5 and 10 percent level, respectively. Likewise to primary education and distance variables, matters in no REDD villages only and significant at 5 and 1 percent level, respectively. However, household size reported to be significant at 1 percent in both villages.

## 5.3 Hypothesis Verification

The first hypothesis of this study is; there is presence of technical inefficiency in agricultural activities. From econometric results from FRONTIER 4.1, indicates that the gamma ($\gamma$) coefficient is 0.95 and statistically significant at 1 percent level. This implies that about 95 percent of farmers' variations in productivity is caused by inefficiency in farming, thus only 5 percent variations is caused by other factors outside the farmers control. Therefore, the study concludes the presence of technical inefficiency among the farmers.

The second hypothesis is social economic variables affects technical efficiency of the farmers in Kilosa District. This was tested on whether the variables included in the inefficiency model have no effects on the level of technical inefficiency. The null hypothesis is rejected confirming that the household's social economic factors affect farming technical efficiency.

Lastly, the study tested the influence of technical efficiency in agriculture on forest conservation, the results shows that inefficiency in agriculture affects forest conservation, more specifically, technical efficiency in farming is negatively and statistically significant related to extraction of forest resources.

# CHAPTER SIX

# CONCLUSION, POLICY IMPLICATIONSAND RECOMMENDATIONS

## 6.0 Introduction

This section presents the summary of the study, policy implications, limitations and recommendations. Section one gives summary of findings and conclusion, section two points out policy implications and recommendations based on the findings, whereas, section three presents study's limitations and recommendations for further research.

## 6.1 Summary of Findings and Conclusion

Majority of the rural households living adjacent to the forest depend primarily on agriculture and secondarily on forest resources. For these households, agriculture plays a key role, as for subsistence needs and as the source of income, forest on the other hand is the major source of energy, building materials and income as well. Highly dependence on these two major activities particularly, as a source of income, reveals that the decrease in return of the main activity, which is agriculture lead rural community to substitute it for the forest extraction. Increase in agricultural production lead the rural communities fulfil their subsistence needs as well as raise their income. Improvement in technical efficiency in agriculture is one way by which agricultural production can be increased as well as rural incomes; therefore the pressure on forest extraction will be reduced.

The study's major objective was to examine the technical efficiency in farming activities and its impacts on forest conservation by the communities living adjacent to the forest. The empirical analysis was based on the data collected from 301 households selected randomly from five villages in Kilosa district, in which three of these villages were under REDD project. Two empirical models were estimated in the study; stochastic frontier (Translog) production function and forest resources extraction models. The stochastic frontier (Translog) production function was estimated by using FRONTIER 4.1 program, whereas Ordinary Least Square (OLS) method was used to estimate forest extraction model. The stochastic frontier production function used the values of output harvested by each household as the dependent variable, and farm size, labour and capital as input variables. Whereas, in technical inefficiency model, the dependent variable was the estimated technical inefficiency, while explanatory variables were sex, primary and secondary education, farm experience, access to formal credit and extension services. For the forest resources extraction model, the dependent variable was the value of forest resources extracted by the household, while explanatory variables were technical efficiency, sex, age and education of the household head, household wealth, off farm income, household size and the distance of the village from the forest.

The empirical findings indicated that the mean technical efficiency ofsmall scale farmers in Kilosa district was 64 percent which implies that small scale farmers still have the room to improve their farming efficiency by 36 percent. This is consistent with the study by Prabodh (2005) which found that the technical efficiency in agriculture in Sri Lanka forest peripheries ranged from 67 to 73 percent. However, the result of technical efficiency scores is higher compared with what was found by Kiraaba (2005) and Hepelwa (2011). The study by Kibaara (2005) found that the technical efficiency of Kenya's maize production was 49 percent, whereas, the study by Hepelwa (2005) found that the mean technical efficiency for Tanzania's maize production was 33 percent. This study used similar approach as the one used by Prabodh (2005) which estimated the technical efficiency of multiple output, unlike the study by Kibaara and Hepelwa which estimated the technical efficiency only for maize production.

In addition, the study found that majority of the farmers from villages under REDD project attained higher level of technical efficiency than farmers from villages were REDD project was not operating. This reveals that agricultural services provided by the project might possibly, contributed in improvement of technical efficiency among the farmers. In addition, farming technical efficiency of the households indicated to be influenced by the level of farming inputs usage as well as sex and educational level of the household head, extension services, farm experience and access to formal credits.

Furthermore the study indicated that, technical efficiency, sex and distance of the village from the forest had negative and significantly related to extraction of forest resources, whereas household size and educational level of the household head shown to be strongly positively related to forest extraction.

## 6.2 Policy Implications and Recommendations

Based on the findings above, it is clear that there is the need of new forest conservation policies, modifying and assisting the implementations of existing ones in Kilosa district and other forest peripheries communities, so as to address the issue of deforestation and forest degradation.

The study indicated that there is the room for technical efficiency improvement by 36 percent. Also among individual farmers, efficiency gap which should be addressed by policy measures ranges from 0.12 to 0.99. The government has to ensure that it undertakes policy programs that will enable farmers to improve their farming efficiency and operate closer to frontier output level without expanding agriculture land towards the reserved forest.

Based on the results, technical efficiency may be improved by providing extension and financial services to the farmers. Majority of farmers in Tanzania have primary level of education, which may not be enough for improving agricultural productivity. The study showed that primary education reduces farming efficiency; however, by providing extension services to a farmer who has at least primary education will improve his/her farming technical efficiency. Hence the Government through its agricultural officers should provide extension services in order to improve farming technical efficiency. In addition, technical efficiency may be improved if rural farmers have access to formal credits. This may be done by extending financial services at district and if possible at village level.

The study pointed out that, REDD project assisted farmers to raise their farming efficiency levels. It is clear shown that most of the forest conservation programs support rural communities through all activities that are drivers of forest exploitation and degradation, and agriculture as one the driver. Most of these projects and programs are operated by NGOs, funded by donors from outside the country and undertaken for a short period. In addition, the involvement of rural communities in projects activities is very low. The government to have its own projects, in which every household farmer benefit from, through its own agricultural officers may be the only way that can make agricultural projects sustainable and reach many farmers as possible. Through this policy, technical efficiency of the farmers may be improved continually and without depending on donor funded projects which take a short period of time. The same pointed by Shively (2001), Prabodh (2005) Fisher and Shively (2006), Lepatu at al. (2009); increasing efficiency in farming may enhance rural incomes and reduce pressure on forest resources extraction.

The findings indicated that female headed households extract more forest products than male headed households. The policy implication for this is, fuelwood is still a main source of energy for majority of the households and mostly collected by females. Furthermore, as pointed by Prabodh (2005), most forest products are considered to be inferior goods by most economies, but a notable exception is fuelwood which is essential for rural developing economies, thus improvement in rural income may not reduce dependence on fuelwood, at least in the short run, unless alternative energy source are available at affordable prices.

The study findings also indicated that there is positive relationship between the household size and forest resources extractions. Based on the results, it reveals that, larger-sized households extract more forest resources than small sized households, and regarding the subsistence nature of the rural households, fuelwood as a major source of energy, the usage of fuelwood depend heavily on the size of the family.

One of the supporting studies for the results is Kabaija (2003), who reported that small sized households (1 to 3) persons predominantly used gas for cooking while larger sized households used fuelwood, which is the cheaper energy source. This difference may be attributed to the fact that more energy is used for cooking than lighting, hence larger sized households cook more food which require more energy, and thus are forced to use the cheaper energy source. In our case, this implies that, for an average household size of 4.3 persons, alternative sources of energy, at least in a short run, may not reduce extraction of forest resources. This is due to the fact that lager sized households, which are predominantly in rural areas and forest neighbouring communities in particular, will opt for fuelwood, a ‘cheap’ source than other alternative sources of energy. There should be favourable policy incentives that could motivate rural households control family size; and eventually, this will help to reduce the size of their families. Thus in addressing drivers of deforestation and forest degradation such as agriculture, fire outbreaks etc. family planning may be another policy component to be addressed so as to reduce dependence and over-extraction of forest resources.

Lastly, the study indicated that, there is negative and significant relationship between the distance of the village from the forest reserves and extraction of forest resources. This is an indication of the villages where the implementation of forest conservation policies may strongly be addressed, given the limited resources problem economics ever face. Villages closely to the forest consume more forest resources than distant villages, thus exploitation of forest resources will be reduced if forest conservation policies greatly achieved in villages closely to the forest.

## 6.3 Limitation of the Study and Recommendations for Further Research

In Tanzania, there are a number of forest reserves and different communities live adjacent to the forest. The forest reserves endowed with different products; in addition to that, community forests utilize different forest products depending on their needs and availability of the products. Therefore the results that obtained from this study might be limited to that particular area, thus unable to make inference to all forest reserves in Tanzania.

Another limitation is that, the study intended to examine the influence of technical efficiency in agriculture on land clearing. However, small number of farmers found to clear land in a year when the study conducted, thus the analysis could not be possible for such small number of observations.

The study used cross-sectional data in estimations of technical efficiency and forest conservation. Other studies may employ Panel data which is better than cross-sectional data especially in efficiency estimations. Panel data accommodates time variant technical efficiencies among the farmers, as well as individual unobservable characteristics that may affect farmers' efficiency. Thus by using panel data, pure farmers' technical efficiencies may be estimated as it separates technical inefficiency from farmers unobservable characteristics.

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# APPENDICES

**Figure A 1: Stochastic frontier production function**

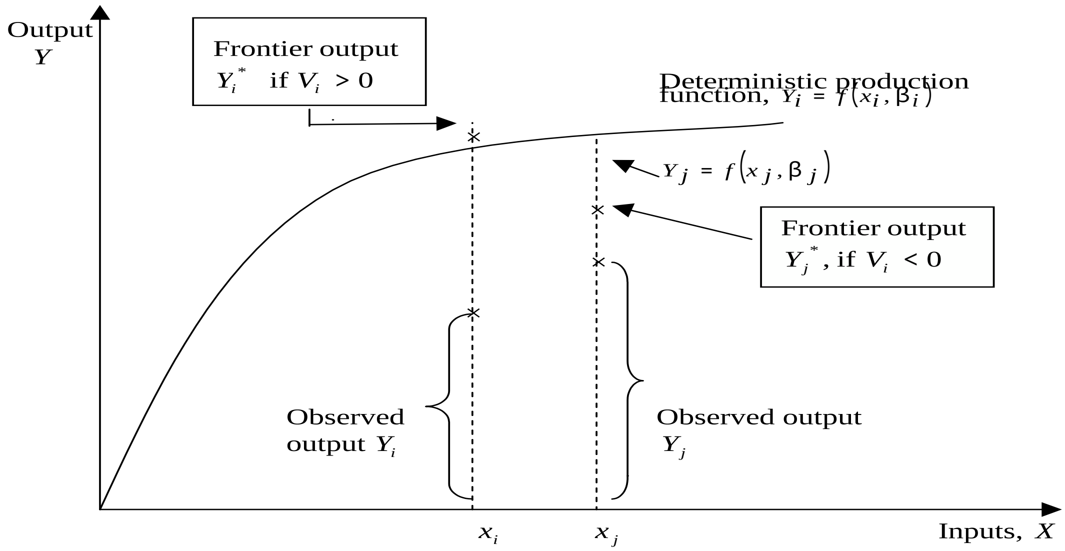
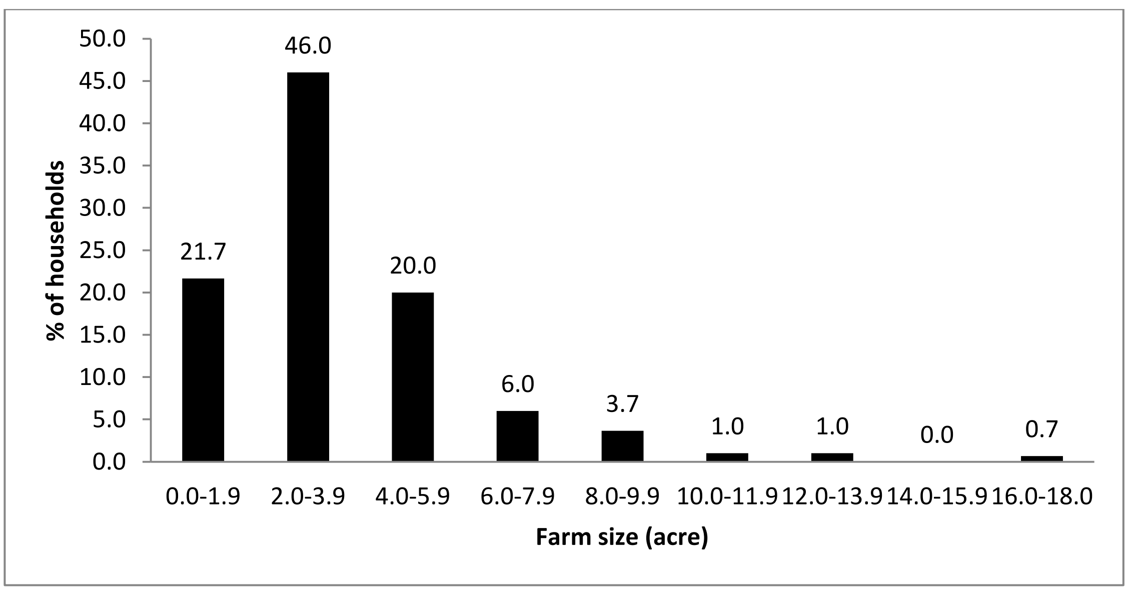
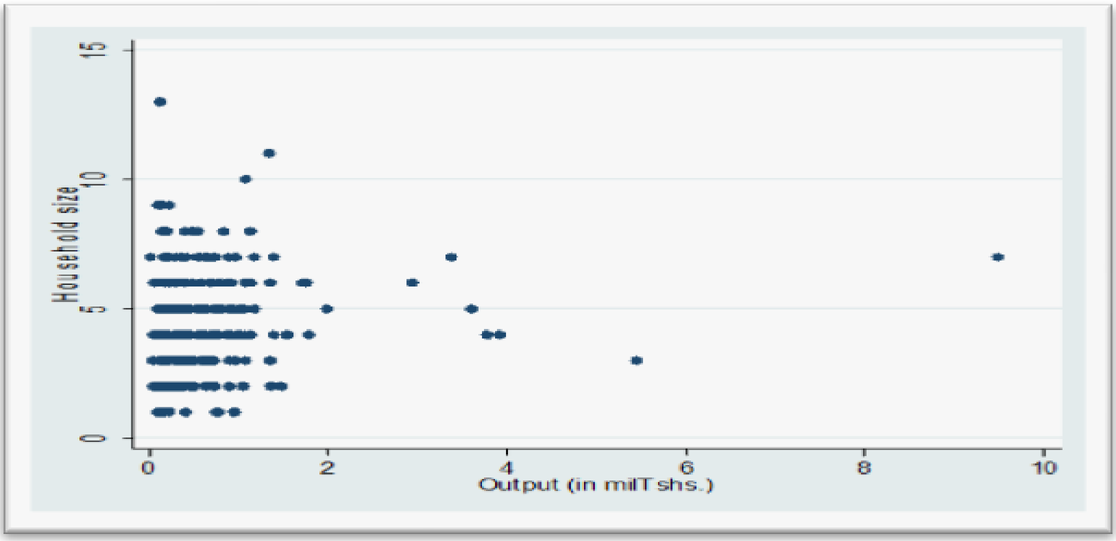



**Figure A2: Distribution of Farm Size among Farmers in Kilosa District**




Source: Author's computation (2013)

**Figure A3: Distribution of Output Harvested by Household Size**



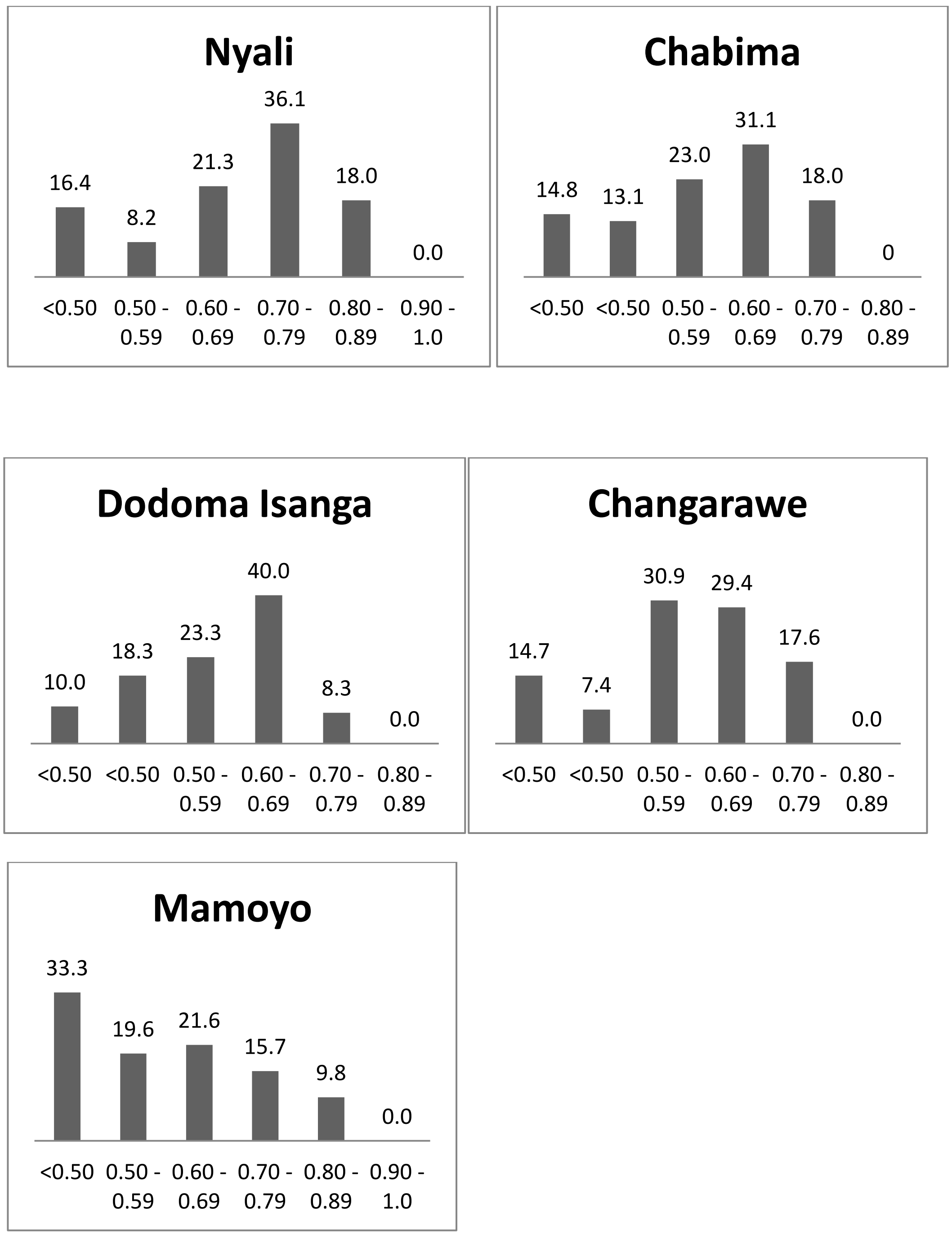

Source: Author's computation (2013)

**Table B 1: Market values of crops and NTFP's in terms of Tshs in Kilosa District**

| Crop name | Weight | Tshs |
|---|---|---|
| Maize | 120 | 45,000 |
| Beans | 120 | 120,000 |
| Sweet potatoes | 50 | 50,000 |
| Cassava | 50 | 15,000 |
| Paddy | 120 | 120,000 |
| Sorghum | 120 | 150,000 |
| Potatoes | 20 | 6,000 |
| Groundnuts | 30 | 60,000 |
| Green tomato | 4 | 1600 |
| Pigeon peas | 20 | 12,500 |
| Cowpeas | 20 | 20,000 |
| Coconut | - | 400 |
| Watermelon | - | 500 |
| Sunflower | | 30,000 |
| Lima beans | | 60,000 |
| Sesame | 120 | 90,000 |

| Forest product | Market value |
|---|---|
| Mushrooms | 300 |
| Forest fruits | 100 |
| Medicine | 200 |
| Thatching grass | 2,000 |
| Fire wood | 500 |
| Fito | 2,000 |
| Charcoal (50 kg) | 9,000 |
| Logs | 3,000 |
| Palm leaves | 50 |
| Ropes | 100 |
| Mirunda | 1,000 |

**Figure A4: Distribution of Technical Efficiency by Villages in Kilosa District**




**Source**: Author’s computation (2013)

**Household Questionnaire**

PART A: HOUSEHOLD ROSTER AND EDUCATION Household ID Code

☐

| INDIVIDUAL ID | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | NAME | SEX<br>MALE……1<br>FEMALE…2 | How old is [NAME]?<br>YEARS | What is /was the highest educational level completed by [NAME]?<br>NOT EVEN STD 4…1<br>STD 4………………..2<br>STD 7……………….3<br>O LEVEL……………4<br>A LEVEL……………5<br>DIPLOMA/FIRST DEGREE…………..…6<br>MASTERS………..…..7<br>DOCTORATE……….8 | What is the main activity of the [NAME]?<br>FARMING..……1<br>FISHING………2<br>MINING………3<br>FIREWOOD…. 4<br>TIMBER …..5<br>EMPLOYEE…..6<br>OWN BUSINESS……7<br>HOUSE WIFE…9<br>NOT ACTIVE…10<br>OTHER (Specify)……….11 | How long have you lived in this area (not necessarily in this house)?<br>YEARS |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |
| 11 | | | | | | |
| 12 | | | | | | |
| 13 | | | | | | |
| 14 | | | | | | |
| 15 | | | | | | |

PART B: HOUSEHOLD WEALTH.

Does your household own any [ITEM/LIVESTOCK] during the last 12 months? YES…1, NO….2□

| 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|
| | | During the last 12 months, did any member of your household own any [ITEM]? | How many [ITEM] did your household own? | What is the value/price of [ITEM] if sold? | |
| | ITEM/LIVESTOCK | YES…1, NO….2 | | Quantity | Price |
| 1 | Bicycle | | | | |
| 2 | Motor vehicle | | | | |
| 3 | Radio | | | | |
| 4 | Mobile phone | | | | |
| 5 | Cattle | | | | |
| 6 | Goats | | | | |
| 7 | Sheep | | | | |
| 8 | Chickens | | | | |
| 9 | Ducks | | | | |
| 10 | Pigs | | | | |
| 11 | Donkeys | | | | |
| 12 | Rabbits | | | | |
| 13 | Dove | | | | |
| 14 | Other (Specify) | | | | |

PART C. FARMING ACTIVITIES.

1. (i) During the last year (November 2011 till July 2012) Vuli and Masika season, did your household cultivate any land (regardless owned or rented)? YES…1, NO…2 □

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| PLOT CODES | Please tell me about each plot of land that cultivated | What is the size/area of the plot? | How many years have you cultivated this plot? | Is this plot irrigated? | In the past 12 months did your household clear new land for | What is the type of the cleared land? | What is the size of the area cleared? |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | by your household during the last season. Please describe or give me the name of each plot | | | | | crop cultivation?<br>YES…1<br>NO…2<br>If no skip question (ii)<br>☐ | | | |
| | | ACRES...........1<br>KIPANDE….…2 | | | YES……1<br>NO…….2 | | arable land…1, forest land…2 | ACRES……...1<br>KIPANDE…..2 | |
| | NAME OF PLOT | AMOUNT | UNIT CODE | YEARS | | | | AMOUNT | UNIT CODE |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |

(ii)Why did your household clear new land for farming?
(a)Output harvested during the last season were not enough
(b)Just to acquire ownership of the land
(c) Advice from the government /agricultural officers
(e) Others (specify)

2. (i) Did you use any inputs like labor, fertilizers or seeds on your farm during the last 12 months? YES...1, NO…2 (>> ii)☐

| | 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|---|

| INPUT CODES | INPUTS | Have you used any [INPUT] on your land during the last 12 months?<br>YES…1<br>NO…..2 | How much [INPUT] did you use on your land during the last 12 months? AMOUNT/QUANTITY | UNIT CODE | Did you receive any subsidies to buy the [INPUT]? YES……….1 NO………..2 , (Provide details on the price and quantity) QUANTITY | PRICE | What was the price/value of the [INPUT]? (all prices computed before subsidy) PRICE | UNIT CODE | Did you receive any extension contact? YES…1 NO….2 , | QTY UNIT CODES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | KG……….1 |
| 1 | Labour (family + hired) | | | | | | | | | KIROBA....2 |
| 2 | fertilizers | | | | | | | | | GUNIA …..3 |
| 3 | seeds | | | | | | | | | BUCKET (20L)…4 |
| 4 | Hand hoe | | | | | | | | | SADO…. 5 |
| 5 | Ox-plough | | | | | | | | | LITRE…. 6 |
| 6 | Ox-seed planter | | | | | | | | | FUNGU... 7 |
| 7 | Tractor | | | | | | | | | TONNE ….8 |
| 8 | Watering can | | | | | | | | | KIJIKO …..9 |
| 9 | Others (specify) | | | | | | | | | OTHER (SPECIFY)……….10 |
| 10 | | | | | | | | | | |

(ii)Why not?

(a) Too expensive to afford
(b) Not available in the village
(c) We don't know the importance of using them
(d) There is no need of using them
(e) Others (Specify)

3. Crop information

1. (i) During the last 12 months, have you harvested any crops or fruits from land owned or rented by the households? YES 1, NO 2

☐

| | 1. | 2. | 3. | | 4. | | 5. | |
|---|---|---|---|---|---|---|---|---|
| CROP CODES | | Have you harvested any [CROP NAME] during the last 12 months? | How much [CROP NAME] did you harvest during the last 12 months? | | How much of the [CROP NAME] that you harvested during the last 12 months was sold? | | What price did you get for the [CROP NAME] that you sold? (Get the average price if more than one price) | |
| | CROP NAME | YES…1 NO….2 | AMOUNT/QUANTITY | UNIT CODE | AMOUNT/QUANTITY | UNIT CODE | PRICE | UNIT CODE |
| 1 | Mahindi | | | | | | | |
| 2 | Maharagwe | | | | | | | |
| 3 | Viazi | | | | | | | |
| 4 | Mihogo | | | | | | | |
| 5 | Mpunga | | | | | | | |

QTY UNIT CODE

KG……….1
PIECE…2
TENGA SMALL(10-15 KG)….3
TENGA MED(15-25KG)…..4
TENGA BIG (25-40KG)….5
KIROBA…..6
GUNIA….7
BUCKET (20L)…8
SADO….9
LITRE….10
MZIGO….11
FUNGU…12

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | Mtama | | | | | | | |
| 7 | Nyanya | | | | | | | |
| 8 | Miwa | | | | | | | |
| 9 | Nanasi | | | | | | | |
| 10 | Nyanyachun gu | | | | | | | |
| 11 | Mbaazi | | | | | | | |
| 12 | Kunde | | | | | | | |
| 13 | Ndimu | | | | | | | |
| 14 | Nazi | | | | | | | |
| 15 | Korosho | | | | | | | |
| 16 | Bamia | | | | | | | |
| 17 | Tikitimaji | | | | | | | |
| 18 | Machungwa | | | | | | | |
| 19 | Ndizi | | | | | | | |
| 20 | Other (Specify) | | | | | | | |

MIKUNGU… 13
TONNE….14
PAKACHA… 15
OTHER (SPECIFY) …16

(ii) What about the prices of the farm products?
(a)Too low
(b) Fair price/reasonable
(c) Very high
(d) Depend on the place the product sold
(e) Other (specify)
(iii)Do you think what obtained in farming activity is enough for the household to survive? Yes…1(>>v), No…2(>>iv)
(iv)What are other alternative sources of income the household has?
- (a) Selling of the forest products
- (b) Non agricultural and non forest products business
- (c) Employment
- (d) Non
- (e) Others (specify)

(v)Do you think it is possible for your household to increase output more than what you harvested during the last season? Yes….1(>>vi), No….2
(vi) What do you think is the better way for the households to increase farm yields?
- (a) Increase agricultural land
- (b) Uses of improved farm inputs
- (c) Attractive prices of farm products
- (d) Both
- (e) Others (specify)

PART D: OFF-FARM INCOME.

1. Household business:

Over the past 12 months, has anyone in your household operated any businesses which produces and sales goods and services and do not include selling of farm or forest products? YES…1, NO …2 ☐

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| BUSINESS CODE | What kind of Business does your household operate? | Who is primarily responsible for the [Business]? CODE | In average month, what are your revenues? TSH |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |

CODE
SPOUSE………..1
DOUGHTER……..2
SON………………3
UNCLE……..…4
GRAND CHILD...5
AUNT…………..…6
OTHERS (Specify)...7

2. Other income.

During the last 12 months has any member of your household received any other income like transfers from relatives, pensions from the Government, income from employment? YES…1, NO…2 ☐

| 1 | | 2 | 3 | |
|---|---|---|---|---|
| SOURCE CODE | SOURCE | During the last 12 months has any member of your household received any income from [SOURCE]? YES…1 NO…2 | How much money have members of the household received from [SOURCE] in the last 12 months? TSH | TIME UNIT |
| 1 | Relatives | | | |
| 2 | State Government | | | |
| 3 | Employment | | | |
| 4 | Labour selling | | | |
| 5 | Pension | | | |
| 6 | Others (Specify) | | | |

TIME UNIT CODE
DAY……….1
WEEK……..2
MONTH……3
YEAR………4
OTHER (Specify)…….5

PART E: FOREST PRODUCTS

1. (i) Did any member of your household collect any product from the forest?

YES…1, NO…2 ☐

| 1 | 2 | 3 | 4 | 5 | | | 6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PRODUCT CODE | FOREST PRODUCTS | Did your household collect any [PRODUCT] from the forest during the last 12 months? YES...1 NO…2 | Who in the household is primarily responsible for collection of [PRODUCT]? ID CODE | How much [PRODUCT] does your household normally collect? | | | How much [PRODUCT] does your household normally sell? | | | |
| | | | | AMOUNT/QUANTITY | QTY CODE | TIME UNIT CODE | AMOUNT/QUANTITY | QTY CODE | TIME UNIT CODE | QTY UNIT CODES |
| 1 | Mushrooms | | | | | | | | | |
| 2 | Forest fruits | | | | | | | | | KG….1 |
| 3 | Medicine | | | | | | | | | PIECE…2 |
| 4 | Thatching grass | | | | | | | | | TENGA SMALL (10-15)KG…3 |
| 5 | Honey | | | | | | | | | TENGA MED (15-25)KG…4 |
| 6 | Fire wood | | | | | | | | | TENGA BIG (25-40) KG….5 |
| 7 | Fito | | | | | | | | | KIROBA…6 |
| 8 | Charcoal | | | | | | | | | GUNIA…7 |
| 9 | Logs | | | | | | | | | BUCKET (20L)…8 |
| 10 | Palm leaves | | | | | | | | | SADO….9 |
| 11 | Ropes | | | | | | | | | LITRE….10 |
| 12 | Wild Meat | | | | | | | | | MZIGO…11 |
| 13 | Minyaa | | | | | | | | | FUNGU…12 |
| 14 | Mirunda | | | | | | | | | MIKUNGU…13 |
| 15 | Others (Specify) | | | | | | | | | TONNE…14 |
| | | | | | | | | | | OTHERS (Specify)…15 |

(ii)What is the distance of the reserved forest from the village? ______(Hrs)_____(Km),

(iii) Do you know the importance of the forest, and its consequences if it is overexploited? Yes…1, No…2

Explain ……………………………………………….

(iv)Why the villagers use forest products?

(a) Alternative products are too expensive
(b) Easier access to forest products.
(c) Alternative products not available in the village
(d) We don't even know if there are alternative products.

(e) Others (specify).

(v) Why do the villagers involve themselves in collection and selling of the forest products?

(a) Income obtained from farming activity is not enough
(b) High demand and attractive prices of the forest products
(c) They don't have farmlands
(d) Farming is seasonal activity
(e) Other (specify)

(vi)Is it possible for the villagers to live without depending on the forest resources? Yes…1, No….2

(vii) If yes, how?

(a) Improving other sources of income
(b) Increase agricultural productivity
(c) Availability of alternative products in the village
(d) Both
(e) Others (specify)

(viii) If no, why?

(a) Farming activity itself is not enough to support our life
(b)There is no other alternative.
(c) I don't know the reason
(d)Others (specify)

PART F: CREDIT

1. Is it possible for you to get a loan from a bank, cooperative, NGOs, SACCOS etc?

   Yes………….1 (>>Q2)

   No…………..2 (>>Q3) ☐

2.In the last 12 months what is the total amount borrowed by your household? TSH …………..

1. Why can't you get a loan? No collateral………………………1

   Process too difficult………………2 ☐
   Lending institutions are too far…...3
   Others (Specify)…………………….4

2. Are you a member of any cooperative union? (4) What is the name of the union? …………..

   Yes………1 (>>4) No……….2 ☐