INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER: A CASE OF UASIN GISHU COUNTY, KENYA

BY

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DECLARATION

This research project report is my original work and has not been presented for a degree in any other university.

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This research project report is dedicated to my family for their unwavering support, prayers a nd patience during the entire preparation period.

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LIST OF ABBREVIATIONS

AFCN	African Forest Conference Network
CFA	Community Forest Association
FAO	Food and Agriculture Organization
FC	Forestry Commission
FD	Forest Department
FRA	Forest Resource Assessment
FR	Forest Reserve.
FRIN	Forestry Research Institute of Nigeria
FSD	Forest Services Division
IGA	Income Generating Activities.
KFS	Kenya Forest Service
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MFW	Ministry of Forestry and Wildlife
MMMB	Miti Mingi Maisha Bora
MTS	Modified Taungya System
NACFA	National Alliance for Community Forest Association
NEMA	National Environment and Management Authority
NP	National Park.
PELIS	Plantation Establishment and Livelihood Improvement Scheme
PFM	Participatory Forest management
REDD+	Reduction in Emissions from Deforestation and Degradation
REMA	Rwanda Environmental and Management Authority
UNEP	United Nations Environmental Programme
WB	World Bank

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ABSTRACT

There has been increasing rate of forest destruction and consequently decline in forest resources in Kenya due to the high rate of increase in human population, thus exerting pressure on natural resources. The decline has been attributed to factors such as deforestation, commercial agriculture, urbanization, pastoralism, charcoal production, forest cultivation, illegal logging, forest fires and replacement of indigenous forests with exotic plantations. Decline in forest resource has been further exacerbated by increasing poverty levels and the community perspective of forest as public good in addition to changing global forest trends. It is on this back drop in forest cover levels that the government of Kenya through Kenya Forest Service modified "shamba system" to PELIS which for a long time has been used by the government of Kenya to raise forest plantations where the forest adjustment communities benefits from cultivation of crops in the forest and KFS benefits from forest plantation establishment at low costs. The key objectives were; to establish the influence of plantation establishment on forest cover, to determine the influence of plantation survival rate on forest cover, to investigate the influence of cost of plantation establishment on forest cover and to assess the influence of livelihood improvement on forest cover. Therefore this study aimed at establishing the influence of PELIS as a strategy to increase forest cover. The study was informed by the theories of Environmental Kuznets Curve and forest transition, which affirms that a U shaped relationship exists between environmental quality and economic development and also contends that forest cover, is an indicator of environmental quality and income levels. Survey research design was used. The study targeted a population of 6521 including 6 forest station managers and 6515 CFA members. Stratified, purposive and simple random sampling methods were used to select forest stations and CFA members for the study. Structured questionnaires, interview schedules and personal observations were used to collect primary data besides use of secondary data from the offices. Descriptive statistics such as means, tables, percentages and frequencies were used. The findings of the study provided an insight on the contribution of PELIS in increasing forest cover. The study established that PELIS contributed to 12.8 % increase of forest cover. The results clearly showed that the survival rates were higher in plantations established with PELIS than those established without PELIS by an average of 75.1% and 45.2% respectively. On the cost of plantation establishment, it was established that the cost was Khs 39,527 with PELIS while without PELIS was Kshs 50,564 representing 27.9% savings. The study also confirmed that there was livelihood improvement as PELIS farmers harvested an average of 22 bags, 54 bags and 5 bags of maize, potatoes and beans respectively. The study also established that 96.3% of CFA members dependent on farming-PELIS as a source of livelihood. It was recommended that there is need to give forest adjacent communities alternative sources of livelihood as incentives so that they could allocate a portion of their land for tree growing, there should also be closer supervision of all PELIS activities to reduce damage to young plantations. Multinational companies should supplement government efforts through provision of funds for reforestation and government should fast track forest management and conservation bill that provides for benefit sharing.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The world's forest, cover some 3500 million hectares, of which 57% of these are located in developing countries mostly in the tropics, worldwide about 1.6 billion people rely heavily on forest resources for their livelihood and estimated 400 million are directly depended on forest resources. Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. It is estimated that the rate of global forest loss has hit 13 million hectares per annum in the last decade (2000-2010) (FAO, 2010). The world looses 7.3 million hectares of forests a year, about four times the size of all gazetted forests in Kenya. Due to extensive reforestation, this new forest shrinkage has slowed slightly from the 8.9 million hectares lost in the 1990s. Despite the decrease, deforestation has not declined significantly since 2000 (KFS, 2014). Globally tropical forests are being reduced at the rate of about 7.5million hectares of closed forest and 3.8million hectares of open forest annually (Lenely, 1982). The global net rate of change in forest cover for normal tropics is estimated to be 23% (Arched *et al*, 2002) signifying a high reduction rate of forest covers.

Closer home, Africa has lost 64 million hectares of forest between 1995 and 2005, the greates decline on any continent during the same period. Fuel wood gathering drives much of the forest depletion. Timber exports also play a role, with 80% of the Congo basin's timber production being exported, mainly to China and European Union. Much of the world's wood is harvested illegally. Illegal logging accounts for more than half of timber production in Russia, Brazil and Cameroon. In addition to devastating forest ecosystems, illegal logging robs forest dwellers of their livelihoods, fuels social turmoil, and deprives timber producing countries of up to ksh. 1.14 Trillion of revenue annually (KFS, 2014).

In the case of Africa, even though most tropical African countries had considerable forest cover at the beginning of the 20th century that ensured environmental stability, the need to increase food production, high demand for wood products and rapid increase in infrastructural development to satisfy growing population has resulted in rapid increase in deforestation and forest degradation (Forestry Commission, 2011). KFS, 2014 observed that forest cover loss leads to; increased occurrence of floods, reduced recharge of ground water, decreased water volume in rivers during dry seasons, sometimes rivers dry up, increased drought periods from an average 2 year cycle to 4 year cycle, increased sediment loads in

rivers, lakes and oceans, changing rainfall patterns, soil desiccation, inadequate timber and fuel wood, loss of bio diversity and intrinsic value of forests amongst others. All these are as a result of climate change.

FAO (2010) observes that, over the last century for example, forest cover in the African region has been under intense pressure from human activities in the name of livelihood sustainability and development. This perhaps explains why Africa now has the second highest rate of deforestation worldwide with 3.4 million hectares of forest loss per annum. Thus the need to seek remedial measures through community, national and global initiatives such as Reducing Emissions through Deforestation and forest Degradation (REDD+) has been well received by many policy makers and governments towards environmental sustainability and green development, as enshrined in the goal seven of the Millennium Development Goals (Karsenty *et al*., 2012). However, the expense of forest areas is declining across the globe partly as a result of logging activities and also due to conversion of habitat to crop land, agricultural expansion accounts for up to 43% of tropical forest losses (MEA, 2005).

This has led to the recognition of the need to include the communities living close to forests through CFAs in management of forest resources to reduce this rate of forest loss. Only 32.5million hectares of African forest and woodlands or 5% of the total forest area are formally protected. The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in western, central and eastern Africa where there in considerable forest cover (UNEP, 2005).

Africa and South America distinguish themselves by showing distinct decline in forest cover. For Africa the direction for the past twenty years is clear even though the rate of deforestation seem to have declined over the last few years. However, forest cover alone does not tell us what kind of forests we have , what benefits they might provide, how well they are managed or if they are degenerated (FAO, 2010). In the Lake Victoria basin problems among other things such as soil erosion and declining soil fertility have been attributed to loss of forest cover (World Agroforestry Centre, 2006). The land was formerly rich in natural forests but this resource has been severely over exploited. Deforestation combined with unsustainable agricultural methods has resulted in widespread, increasingly conspicuous land degradation (Maitima *et al*., 2010). As a result of the above, there is need to stop further deforestation through conventional strategy to save biodiversity for the survival of human

kind.

According to MMA (2008), Africa has high per capita forest cover of 0.8 hectares per person compared to 0.6 hectares globally. On average forests account for 6% of GDP in Africa which is the highest in the world. In Uganda for example forests and woodlands are now recognized as an important component of the nations stock of economic assets and contribute in excess of US $54.6 million to the economy through forestry, tourism, agriculture and energy. The state of Rwanda's forests and woodlands and their importance to the national economy is also well documented. Forests are designated as protected areas which host game parks and forest resources and make contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. They also make an indirect contribution to sustainable agriculture and are sources of medicine, fodder, honey, essential oils as well as handcrafts and construction materials. However, they are also threatened by mining, fires and poaching (REMA, 2009).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. FAO, 2013 noted that there has been a straight line decrease in forest cover in Kenya between 1990 and 2012 ie 1990 37,080km^2, 2000 35,820km^2 and 2012 34,450 km^2. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

Muthike (2004) notes that forests plays a vital role in water catchment protection, climate change mitigation, agricultural production, hydroelectric power generation, habitat for wildlife, ecotourism, food, employment, income, research and education among others. In addition over 1 million households, living within a radius of five kilometers from the forest reserves depends on the forests for cultivation, grazing, fishing, food, fuel wood, honey, herbal medicine, construction materials, water and other benefits (KFS, 2012). Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

Despite all these importance, the forests are under tremendous pressure from growing population and therefore innovative strategies are required to support their sustainable management (KFS, 2012). Forest cover in Kenya has been decreasing over the years and the main drivers have been poor legislative frame work and governance, politics, encroachment, illegal cultivation, illegal logging, charcoal burning, excision, poverty, population pressure, industrialization and poor understanding of the benefits of forests by the local communities.

World Bank (2007) observes that sawn timber remains highly valued and in short supply in Kenya for a number of reasons. One is that the land available for forest is diminishing in medium to high potential again ecological zones. Forests in such places face direct competition from land for agriculture, infrastructure and urban development estimated at 5,000 excerbarated by an increasing population on limited available land is dramatically reducing forest acreage. The enactment of the Forest Act 2005 as admittedly helped to revitalize the section by giving local communities a stake in the management of state and county forests.

As in many countries, Kenya official status do not accurately reflect the extend of forest resources as a contributing factor to the economy. These gaps fuel the perception that forests meet substitutes needs only and is therefore not important. Data for the period 1989-2005 indicate little change in forest cover yet known existence suggest the figure for gazetted forests should be lower. Conversely extensive tree planting which took place under the afforestation and extension scheme on private land and state forests and in some forests managed by local authorities should show higher forest cover in these areas. It is therefore recommended that a participatory approach to formulating and implementing forest policies is adopted in order to ensure local communities support (KFS, 2014).

1.2 The Concept of Taungya System

1.2.1 Taungya System in Thailand

In Thailand, a country that neighbours Burma, the destruction of forest through shifting cultivation was a serious problem. More than 10,000 hectares of forest lands were denuded annually by hill tribes and other farmers . Forest village scheme was introduced by the government and Forestry Organization as an attempt to stop further spread of shifting cultivation and deforestation. The forest village system offered hill tribesmen and others who practiced slash and burn agriculture considerable inducements to settle down. One of principle aims of the scheme was to keep a steady labour force on

hand for long term needs of forestry, while at same time providing rural families with income and other benefits from the kind of farming they choose to practice (S A O Chamshama *et al.,*1992).

The underlying principle of the scheme was to link reforestation with social welfare of the people involved. A systematic programme of public information and the involvement of community leaders were necessary to gain public acceptance of forest villagers before they could be started in the FVS, the families were allowed to grow crops during the first three years of establishment. The families were also provided with free agricultural advice, primary education and medical services. Families who agreed to give up shifting cultivation for settled land use were given tenure of a plot of land to construct a house and develop a home garden, where crops could be grown and few animals reared. In return the farmers were required to help establish and maintain forest plantations. (S A O Chamshama *et al*.,1992).

Although the scheme rain well below targets, opportunities had been provided for people to settle, with long term employment prospects and affording a higher standards of living than previously. The families had abandoned shifting cultivation thus reducing pressure on native forests. Also, through forest villages biodiversity had been improved. Not with standing numerous weaknesses and constraints of the scheme were identified, which included setting up of villages with promised facilities required significant expenditure, there was scarcity of capable managers to oversee the village functions, where forest was still plentiful, ensuring adherence to forest village policy was difficult, and so illegal shifting cultivation continued ; some sites were on steep slopes with poor soil, thus cultivating crops was hard and yields were low, cash flow problems arose as payment as payment of bonus were not made until the end of the first year of participation. Furthermore, financial incentives were too low for some ,resulting in their leaving to seek work elsewhere (S A O Chamshama *et al*.,1992).

1.2.2 Taungya System in Uganda

In Uganda, taungya has been practiced for many years. Uganda admits taungya to be a good practice of carried out properly like it was done in Burma. By planting trees with food crops weed invasion was prevented and soil cover was retained and through taungya there was a maximum use of land as both crops and trees were grown. Also employment was provided over a large scale.(tree growers and crop growers are all

employed) and there was cheaper forest establishment and protection and whose legummous crops were grown, the nitrogen benefited the trees, yet and certainly most important, taungya system promoted food security. However, over the past 30 years or so, the results of taungya have been disastrous in terms of establishment of tree plantations. Farmers faced with possibility of becoming landless, once the trees are fully established often damaged or killed the trees (S A O Chamshama *et al.*,1992).

In some parts of Uganda , farmers severely pruned the trees branches to prevent them from shading their crops, whereby extending the period they can use the land for their crops. In some instances, farmers physically uprooted the trees (or partially uprooted to severe some of the roots) to further extend the period they can grow their crops, some instances of heaping weeds on top of saplings had also been recorded. Furthermore, the farmers planted unacceptable crops such as planting tall crops, like maize and sorghum, which soon overtopped the trees so weakening and killing them, several crops species are known to be controversial and are excluded in forest plantations in some countries, such crops include bananas and plantains. (Musa spp), Cassavas (*Manihot utilissima*) and sugar cane *Sacharum officinarum*). Sugar cane for example, is generally extended because it is a long growing crop, so it is feared to deplete the soil and because it casts a heavy shade, Also it is known that allelepathic effects exists in which sugar cane suppresses the growth of trees seedlings (S A O Chamshama *et al.*,1992).

Most Taungya problems in Uganda were reported to have been caused by luck of adequate supervision. To redress the situation and to ensure equitable access to forest resources, the government of Uganda formulated policies and laws to ensure that communities, especially vulnerable ones participated in decisions that affect their livelihoods. One such policy was that of collaborative forest management (CFM). CFM is an approach that enhances community participation and development of partnerships for Forest management. In areas where CFM is implemented that is better enforcement of forest rules (D .A. Ndomba *et al.*, 2014)

1.2.3 Taungya System in Ghana

In Ghana about 75 percent of her forest plantations were established using taungya system in the earliest version of taungya that was launched in Ghana in 1930, the farmers had no rights to benefits accruing from the planted trees. Also, the farmers had no decision making role in any aspect of forest management. A s as a result , the farmers

tended to neglect the tree crops since they would not directly benefit when it matured. The farmers also realized that if the tree canopy closed, they would be asked to stop farming to enable the establishment of the tree crop from which they would not benefit. Consequently, most farmers deliberately killed the trees so that they would not be asked to stop farming. Other evils committed by the farmers included clearing more land for plantation development than was needed for available seedlings. They failed to weed around the seedlings , there by retarding their growth so as to extend land use rights beyond three years; the farmers also illegally farmed other areas of the forest reserved whether degraded or not (S A O Chamshama *et al*.,1992).

Furthermore, the farmers planted food crops most were not compatible with the tree crops leading to reduced tree growth. Other problems included lack of supervision by the forestry department; inadequate financing mechanisms and abuse of power by public officials, especially in farm allocations. As a result, the system was suspended in 1984. Following these observation the taungya system in Ghana was revised in 2002 to make itself financing and sustainable and partly to provide employment and alleviate poverty in the rural communities. (S A O Chamshama *at el*.,1992). In the new version, the farmers became owners of forest plantation products while (FC) and forest adjacent communities were shareholders. The farmers provided labour, did pruning and maintenance and tending of forest plantings; the Forest Commission provided technical expertise, farmers training, provision of equipment and tools , stock inventory and marketing of forest products; the land owners contributed land while the forest adjacent communities provided the services of protecting the investment from fire.

The consultation process devised an equitable benefits sharing frame work based on Contribution of the participants. These levels of contribution together with stakeholder expectations led to the following benefits sharing framework; The farmers get 40% of Timber benefits; the forest communities gets 40% , the land owners get 15% while Forest adjacent communities get 5% of the benefits accruing from the Modified Taungya System (MTS). This was to ensure sustainable system and continuous flow of benefits to participating farmers after harvest of food crops at the end of third year and there should be some bulk payment at the time of harvesting logs. (O. A Ndomba *et al*., 2014)

1.2.4 Taungya System in Kenya

In Kenya, Taungya system was adopted in 1910 and was referred to as shamba System. First introduced as a modified form of the taungya used in south East Asia; the shamba system was a method, of forest plantation established in which farmers tend tree saplings on state owned forest land in return for being permitted to intercrop food crops until canopy closure. The shamba system significantly reduced the cost of forest establishment as weeding costs were borne by the farmers. The system also provided significant benefits to farmers in the form of food.

In 1990s the shamba system was often abused and young trees were often neglected or deliberately cut to enable cultivation to continue beyond the usual three years period. These actions slowed down reforestation progress and resulted in vast areas of land under cultivation within forest reserves. Following these mishaps the system was banned by presidential decree in 1987, and in the following year all forest residents were evicted from forest areas. The shamba system was subsequently replaced by

A modified system referred to as Non- Residential Cultivation (NRC). In the NRC, farmers were Integrated into the Forest Department (FD) as resident workers. Under NRC the farmers were allocated plots , still by the name ,shambas' but with guaranteed work for nine months per year. The produce from the shambas was considered part of workers emolument as they tended the young trees. This NRC too was banned after a few years and was being replaced with a redesigned system referred to as the Plantations Establishment and Livelihood Improvement Scheme (PELIS). The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation (O.A. Ndomba *et al.;* 2014).

1.2.5 Justification for Plantation Establishment and Livelihood Improvement Scheme (PELIS)

PELIS involves farmers planting and tending the saplings on a state owned forests in r eturn for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years). Before being allowed to cultivate in the forest they sign a PELIS cultivation permit where they commit themselves to abide by the rules and regulations that govern the scheme (Appendix vii). The scheme is meant to improve the economic gains of participating farmers while ensuring success for planted tree (AFCD, 2012).

In mid 2007, acting in conformity with the Forest Act 2005, the Kenya Forest Service (KFS) in collaboration with key sector partners particularly forest adjacent communities revis ited the pros and cons of Non –Residential Cultivation (NRC). KFS outlined a new model, re-branded as the Plantation Establishment and Livelihood Improvement (PELIS).

The overall objective of PELIS was to establish forest plantations and improve the livelihoods of communities through sustainable collaborative management of gazette forests. The PELIS initiative was to have the following other objectives.

1) To reduce the cost of plantation establishment that currently stands at Kshs.25.000 per hectare at three years using the pitting and spot weeding method as compared to about Kshs.10,000 per hectares under shamba system (by 2007).

2) To improve the rate of growth of the planted stock as would be the case under complete cultivation as compared to pitting and spot weeding method.
3) To allow the people leaving next to forest reserves improve their food security and incomes through raising of crops together with trees in forest reserves and hence change their attitudes to forest conservation.
4) To reduce and eventually eliminate replanting backlogs that currently stands at 16,000 hectares.
5) To minimize the need to seek assistance in plantation establishment from forest based industrial companies.
6) To minimize the need for KFS to hire labour for plantation establishment.
7) To achieve sustainability in harvesting and replanting of plantations. (KFS, 2007)

1.3 Statement of the Problem

Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. Forest underpin important sectors of the economy including agriculture, tourism, energy, water and manufacturing among others. Further 80% of the population depends on wood as the primary source of energy.

Kenyans population is on the rise and stood at 38.6milion in 2008 and at the 2.9% growth rate. The resulting high demand for forest and woodland products by arising population created led to conflicts and environmental degradation as forest are cleared to make way for human settlement and agriculture, industrialization, frequent drought in Narok,

for instance are attributed to the rapid growth of settlement and the increased rate of deforestation by conversion of burning and illegal logging upstream in the Mau forest.

It was on this background of the myriad products and services that forests provide to human kind and other flora and fauna. Hence it was important to check on the growing negative effects of climate change that is aggravated by the continued deforestation with the key driver being human induced activities. PELIS as strategy is capable to reverse the trend if well managed and the rules and regulations governing the scheme are observed to the latter.

1.4 Purpose of the study

The purpose of the study was to establish the influence of Plantation Establishment and Livelihood Improvement Scheme (PELIS) on forest cover.

1.4.0 Research Objectives

1.4.1 Objectives of the Study

1. To establish the influence of plantation establishment on forest cover.
2. To determine the influence of plantation survival rate on forest cover.
3. To investigate the influence of cost of plantation establishment on forest cover.
4. To assess the influence of livelihood improvement on forest cover.

1.5 Research Questions

1. How does plantation establishment influence forest cover?
2. How do plantation survival rates influence forest cover?
3. How does the cost of plantation establishment influence forest cover?
4. How does livelihood improvement influence forest cover?

1.6 Significance of the Study

The continued degradation of forests resources calls for concerted efforts by the policy makers and researchers to slow or stop the loss of forest cover. The findings of the study will help the policy makers in the industry to know the level of success or failures of PELIS and make the necessary adjustments if need be. The researcher will be able to fill the

knowledge gap in terms of the role of PELIS in increasing forest cover. The government will also be able to appreciate the role of PELIS in terms of bridging the gap on food insecurity.

KFS as a key player will be able to determine whether it is working towards achievement of 10% forest cover as envisaged in the constitution and the internationally recommended thresh hold. The study will also influence level of participation of donors in the sector by having confidence and continue funding if the forest cover level increases. Positive results will gear the country towards economic development by improving the key sectors of the economy like industries, agriculture, energy and tourism that largely depend on sustainable management of forest resources.

1.7 Basic Assumptions

The study assumed that all the six forest stations under the study are practicing PELIS and by extension have Community Forest Associations (CFAs). The planting backlogs have substantially been reduced. The researcher assumed that the respondents will cooperate and give honest response to the questions in research tools. It was also assumed that the sample size chosen was adequate to enable the researcher draw valid conclusions on the study.

1.8 Limitations of the Study

In the course of the study it was difficult to obtain the updated information on the plantation records. The CFAs also provided varied information on food production through PELIS, this was overcome through verification of secondary data with field data, interviews and personal observations. Weather, difficult terrain and vast areas of some forest estates also posed some challenges during data collection in the field this was lessened by visiting the field early in the day and putting on the right attire. Language barrier was also a challenge and was minimized through an interpreter. The study used structured questionnaires, secondary data and interview schedule as data collection tools besides personal observations.

1.9 Delimitations of the study

The study covered the six forest stations in Uasin Gishu County. As anything more than this could not be viable given the time limit and resources available especially funds. Given that NRC was modified to PELIS in 2007 and its implementation started in 2008 in selected stations in the country. The study covered plantations established 2001-2014.

1.10 Definition of Terms

Plantation Establishment and Livelihood Improvement Scheme

PELIS involves farmers planting and tending the saplings on a state owned forests in return for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years) (AFCD, 2012).

Plantation Establishment It encompasses species selection, site clearing, staking out, pitting and planting of the tree seedlings in the field.

Forest cover It is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production system (for example in fruit plantations and agro forestry systems) and trees in urban parks and gardens (FAO, WB, 2015) It is an area more than 1 ha in extent and having tree canopy density of 10% and above.

Livelihood It is a means of making a living. It encompasses people's capabilities, assets (including both material and social resources), income and activities required to secure the necessities of life.

Livelihood improvement This is when livelihood is sustainable and it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conways,1991).

Planting Backlog These are un stocked areas that were either clear felled or opened up for PELIS but have not been planted.

Survival Rate It is the percentage of saplings surviving after six months of establishment in their natural environment.

Sapling A young tree, especially one not over 10cm in diameter at breast height.

Acquaforestry It is the science of raising acquatic animals and trees.

Apiculture It is the management and study of honey bees.

Taungya It is a Burmas word meaning hill cultivation; it was introduced

in India in 1 890. It is a modified form of shifting cultivation in which labour is permitted to raise crop in an area but only side by side with the forest species planted by them.The practice consist of land preparation, tree planting, growing agricultural crops for 1 – 3 years until shade becomes dense and then moving on to repeat the cycle in different areas

1.11 Organization of the Study

Chapter one represents background of the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study. It also entailed delimitations of the study and definition of terms as used in the study. Chapter two covers review of related literature on plantations establishment, plantations survival rate, costs of plantations establishment and livelihood improvement on forest cover. Theoretical and conceptual frameworks and gaps in literature review were also highlighted.

Chapter three described research methodology, which included research design, target population, sample size and sampling techniques, research instruments, pilot testing and data collection procedures, data analysis and ethical considerations. Chapter four gives detailed analysis, presentation, interpretations and discussions of the study findings while chapter five reviews the whole study summary, conclusions and recommendations based on the study findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter looks at both theoretical and empirical literature related to plantations establishment and livelihood improvement scheme (PELIS) and its influence on forest cover. The chapter also reviews the independent variables in relation to the dependent variable. It also identifies knowledge gaps that are as a result of analyzing the theoretical and empirical literature.

2.2 The Concept of Forest Cover

Deforestation in all of the Kenyans five water towers is mainly due to poor environmental governance. This consequently include loss of forests cover, increased soil erosion, drying or rivers and stream, siltation in dams and increased cost of forest related products such as timber (NEMA, 2005). Forest and woodlands are particularly vulnerable to climate change. This is because the impact of climate change and variability led to change in land cover and land use, increased incidences of pests, diseases and fire outbreaks and foment loss of livelihoods (Ogwang *et al*, 2010). Apart from offering oxygen, fuel and building materials, trees store important quantities of carbon , which if released, contribute to global warming (FRA, 2015). Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water resources which loses its quality as forests condition worsens (MEA, 2005).

Over 80% of Kenyans rely on wood biomass for their energy requirements, which exerts considerable pressure on the tree and forest resources. In addition, the wood conversion technologies for timber manufacturing and charcoal production are obsolete and wasteful leading to overharvesting of trees to meet the demand. Globally and nationally the climate is changing, and this is having a direct impact on forest resources and ecosystems and on people and their livelihoods flooding, landslides and drought. Forestry can play an important role in both mitigation and adaptation to climate change, and towards green growth. Forest plantations supply industrial wood and also play a crucial role in conserving biodiversity, providing habitat for wildlife, conserving soils and regulating soils and regulating water supplies and sequestering carbon dioxide, they also reduce pressure on the indigenous forests (Forest policy, 2015).

Of late weather patterns have changed in the county especially rainy seasons comes late, the rains are erratic, prolonged and intense droughts coupled with drying up of rivers and springs. The price of forest products have also been ballooning due to acute scarcity. It is therefore on this background that the study explored the influence of PELIS in increasing forest cover in state forest areas to mitigate on the above mentioned challenges. Demand for sawn timber, furniture, timber packaging and less end use is increasing as building construction is expanding and standard of building is improving. Consumption in 2010 is estimated at 855,000m3 consisting of Kenya production of 760,000m3 and imports of 95,000m3, (MMMB, 2013).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

MFW,2013 observed that forests in Kenya including plantations are important in conservation of biological diversity, regulation of water supplies; carbon dioxide sequestering and are major habitats for wildlife which promotes tourism. Forest conserves water catchment areas. They also provide water to support irrigation schemes that are important for agricultural sector development (ICFW, 2013). M Nichlon, 2000 observed the role of native forest as to restore ecosystem services like water quality, water provision, air quality, soil quality, soil conservation among others. Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

2.3 Policy and Legislation to Improve Forest Cover

Kenya’s forest cover is disappearing at an alarming rate. According to sessional paper No.1 of 2007 on forest policy; our forest cover was less than 2% of the total land area as opposed to internationally recommended standards of at least 10%. Lack of adequate

budgetary allocation by the treasury and staff shortage made it necessary to involve the community in a forestation exercise. The PELIS strategy was expected to deliver benefits of increasing the forest cover by involving the forest adjacent communities who were directly affected by both positive and negative activities in the forest.

The forestry sector has been characterized by ineffective regulatory mechanisms and inadequate law enforcement. The Forest Act no. 7 of 2005 that became effective in 2007 was a milestone in forest governance and brought about Community Forest Association participation in plantation establishment through non resident cultivation and protection of the forest resource (Forest Act no. 7 of 2005). Further the promulgation of the of the constitution brought new requirements for natural resource management such as public participation, equity in benefit sharing, devolution and the need to achieve 10% forest cover among others (Constitution of Kenya 2010; Vision 2030, 2008). These challenges are compounded by dwindling public land, which need incentives and clear methods of engagement to encourage investments in commercial forestry on private land. The policy statement is to promote private sector participation in establishment and management of plantations through appropriate forest management arrangements and incentives and promote species diversification through planting of indigenous and exotic species with proven potentials (Forest policy, 2015).

Over the last few decades, policy makers have advocated and applied forestry decentralization as an appropriate means of environment protection and sustainability. (Anderson, 2006).This has often been done with the motivation to increase the involvement of forest based communities and local institutions in forest resource management. Their assumption is that the local people's involvement in forest resource governance is the most appropriate means of ensuring sustainable forest resource management and green development (Robert and Larson, 2005, Ribot and Oyoro, 2006). In pursuit of its commitment to reverse the degradation of forest for examples, the government of Ghana, in 1996, launched the forestry and wildlife master plan to reverse deforestation between 1996 and 2020 which is estimated at 65,000 ha per annum (Forestry Commission, 2001).

Against this background, the forestry sector in Ghana has implemented a number of decentralized schemes (Marfo, 2004). One of them for which the issue of livelihood development and forest reclamation are so crucial is the modified Taungya system (MTS). In 2001 the government Ghana launched the MTS as a decentralized mechanism to halt and reverse degradation of forest resources as well as build community resilience for enhanced

rural livelihoods and poverty reduction. The MTS is a decentralized forest management strategy in which communities are given portions of degraded forest reserve to inter-plant food crops with trees and further nurture trees into maturity under an agreement in which costs and benefits sharing are specified .In this arrangement the forestry commission of Ghana transfers responsibilities to selected forest fringe community members and established local authorities as partners both in managing and drawing benefit from forest reserve to ensure local communities commitment to sustainable forest governance. After over a decade of the MTS, implementation its viability to achieve or deliver livelihood security, forest resource recovery and poverty reduction at the local arena require monitoring and verification (Prince Osei *et al*.,2008).

The Modified Taungya System (MTS) involves the establishment of plantations by the government (FC) in partnership with farmers. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The farmers are allowed to cultivate food crops which are planted between the trees on the same lands. As the farmers does all the labour while not getting paid for it. They will have a share in the future timber revenue. They are entitled to 40%, whereas the government also gets 40% and the land owner and community will obtain 15% and 5% respectively. Many farmers in the MTS are migrant farmers; they go back after 2 years. So the plantations are abandoned, which is not good for the trees as they need to be maintained. It is better for the plantations that the stay for a longer time. The original Taungya system was modified and extended with the benefit sharing scheme because the scheme was boycotted by the farmers due to lack of benefits and voice (Interview Zonal plantation managers of the FC, 2010). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

In recognition of the important role that increased forest cover and food security plays coupled with the challenge of inadequate funding towards forest plantation establishment. The government of Kenya through (KFS) modified "shamba" system which for a long time has been used to raise forest plantations where the forest adjacent communities through

(CFA) benefit from cultivation of food crops in the forest during the early stages of forest plantations establishment of forest plantation at a low cost (Mwatika *et al.*, 2013). Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced as a policy guideline to address the decreasing trend of forest cover. The scheme has been used to establish forest plantations since 2007.

A review of the past studies on the shamba system shows that success and failures depends on how well government guidelines are implemented and enforced when the system was reorganised in 2000, success rates climbed and again recede after the 2003 ban. Funds allocated to the FD for forest operations are grossly inadequate declining from kshs 390 million in 1996 to 95 million in 2004. Though planting has increased, fewer seedlings are surviving, rates have declined from as high as 90% to as low as 10% in some stations (Kagombe *et al.,* 2005).

Since 1968, the country has experienced a major decrease in forest cover which has resulted in reduced water levels, bio diversity, supply of forest products and habitats for wildlife. Also according to sessional paper No 1 of 2007 on forestry policy, the forest sector has been faced with conflicts between forest managers and forest adjacent communities over access to forest resources. In response to increasing back logs and adequate resource capacity within the forest department to reestablish plantations, the shamba system was reorganized and reintroduced in a few districts as NRC in 1994.

2.4 Plantations Establishment and Forest Cover.

Nair (1985) indicates that, in case of severe deforestation, programmes are important to restore the tree cover. When plantations are established, they can provide a sustainable tree cover, but working at the biodiversity and environmental services compared natural forests, the plantations are poor in supplying them. Forest plantations have more potential to grow food crops, as the space between the trees can be used to grow food crops during the first years of plantation establishment. This could be beneficial for people who live and work in forest plantations. So plantation establishment development can be seen as part of agriculture, more specifically as specific type of agro forestry, namely an agrosylvicultural system.

Various options exist for plantations establishment for higher growth and survival rates. Total cultivation though expensive is the most appropriate .In the absence of more resources, NRC is the most viable method. A well-managed NRC has a similar effect to total cultivation ,costs are shared by the community and the forest department and both benefit

(Kagombe *et al., 2005*).without viable alternatives in sight the government should review the ban on NRC in areas where it has been working and establish mechanism to make it work in areas where it has failed .Further to that the FD must recognize the importance of community participation in forest management and in particular the role of the NRC management committees (Kagombe *et al.,* 2005). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

The Kenya forestry sector is today characterized by the problem that the rate of forest estate clear fell does not match the rate of replanting. This results in a rise to backlogs in plantation establishment. For example, of the 170,000 hectares of government owned forest plantations, 20,000 (12 %) hectares are open land or where recently felled and not replanted. Backlogs in forest plantation establishment refer to delayed operations in tree establishment and tending. By 1995 there were a total of 17657 hectares of planting backlogs, 1338 hectares of thinning backlogs, 22,750 hectares of pruning backlogs and 2175 hectares of coppice reduction backlogs (Wanyiri report, 1995). The Ol bolossat forest had over 1000 hectares of forest planting backlogs due to unsustainable tree harvesting and poor plantation establishment but the CFA through PELIS has reduced the backlog to less than 300 hectares (KFS, 2011). Most of the natural forest suffered degradation but now the communities are carrying out rehabilitation of degraded catchment areas.

The aim of KFS plantation programme is to have a sustainable production of forest products that will satisfy the present and future demand. This can only be ensured by timely replanting of harvested plantation areas. In recognition of the need to increase the forest cover in Kenya, the government through sessional paper no.1 of 2007 on forest policy provides guidelines for intensified tree planting inside and outside gazetted forests. Availability of high quality tree seed is key to realization of this policy. Seed quality is assured through KEFRI who is mandated to provide certified, site appropriate, high quality tree seeds in sufficient quantities to meet the national demand. KEFRI endeavors to best practices throughout seed production chain to ensure provision of high quality seeds (KEFRI, 2011). CFAs helped in tree operations and raised some 10.5 million tree seedlings during 2011/2012 compared to 5.8 million seedlings raised by KFS alone per year (KEFRI, 2011).

When the presidential ban came into force in 1999, the planting backlogs stood at 46,000 hectares but replanting efforts have since reduced it to 15000 ha. From 2002 to date

20,000 hectares of industrial forests plantation have been established through PELIS in gazetted forests all over Kenya. During the financial year 2011/2012 KFS had 16, 281 hectares of forests plantation under PELIS. The higher survival rate from 20% to 80% was due to better care for tree seedlings by PELIS farmers and improved forest governance by KFS. Improved tree cover has contributed towards achieving vision 2030's target of 10% forest cover which currently stand at 6.9% of the total land area.

KFS (2007) confirms that, the established young trees are from certified seeds, grows at high rate, fixing an average of 2.7 m3 carbon per hectare from one to age four. This leads to clean environment and reduction of global warming as stipulated in the Millennium Development Goals (MDGs, 2001). Shamba system (PELIS) is allowed under the Forest Act 2005 and is recognized as one way of raising plantations. One way to ensure that people benefit from forest is to allow system such as this, which benefit both the government and farmers.

Those plantation established under monoculture regime interfere with the forest biodiversity, and reducing its water catchment qualities. Farmers have been told to keep off indigenous forests. The noble peace prize laureate Prof. Wangari Maathai contends that "We cannot sacrifice indigenous forest at the expense of exotic plantations". Plantations represent a monoculture of trees, but a forest on ecology system. Maathai affirmed ‘' we are destroying local diversity and greatly the capacity of the forest to be effective water reservoirs (Paulo M, 2010). Forest scarcity induces higher prices of forest products, which encourage both better forest management and the establishment of woodlots and plantations. (Rudel *et al*., 2005) refer to this as the forest scarcity path, which forms the other main route towards forest transition. The success story of Machakos in Kenya provide an example (Tiffen *et al*., 1994)

On the Kenyan side, where piloting a livelihood plantations are being piloted under the PELIS, the system is dominated by maize rather than trees, with respect to quality, the tree will grossly under perform in terms of yield o timber of transmission poles, which people hope to sell at the end. Generally the PELIS approach as it is being implemented now will yield limited benefits in terms of improving forest cover and forestry products and services,

2. 5 Plantations Survival Rate and Forest Cover.

According to Kagombe *et al*., (2005) to attain an increased forest cover, the survival of the planted tree seedlings must be guaranteed. And this is possible through PELIS. As the farmers tend their crops by removing weeds and adding fertilizers the saplings too benefit as

they are not subjected to competition for nutrients with weeds and also they get nutrients from fertilization hence increased survival rate. Given that hygiene of the seedlings is secured through PELIS, higher survival rates for seedlings and lower susceptibility to pests and diseases.

The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004). It is paramount that to achieve a sustained forest cover from PELIS, then law enforcement efforts must be doubled. This will ensure that illegal activities that degrade the forest i.e. deforestation are controlled. The programme PELIS is improving tree cover in gazetted forest areas since it helps to improve survival rate and establishment of forest stands (M Nichlon, 2000). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012).

The reason for committing forest offences are often because of ignorance of the law and negligence They also include poverty, unemployment and the collections of medicinal plants for commercial purposes. Widespread bribery of forest guards and local police, lack of support to junior officers, shortage of vehicles and other equipment in the field to collect evidence of infractions and inadequate fines or sentencing continue to hinder enforcement efforts (World Bank, 2007 a) and create conflict between the authorities and communities in many natural forests.

Although the command and control approach of the past emphasizes law enforcement rather than crime prevention, low enforcement rather crime preventions, KFS understands that it must integrate compliance measures with greater efforts to involve communities in forest management which includes PELIS (Geller *et al.*, 2007). As the farmers tend their crops they also protect the young and the old trees from illegal poaching and destruction. The hygiene they keep in the PELIS areas also help in keeping off pests, diseases and also reduce incidences of fire outbreak. It is recognized that the current trend in forestry management is to move towards participation of communities in management of forest resources. It is difficult to police forests especially in areas where high population surrounds it. The communities are therefore involved in conservation and protection.

The way forward for shamba system is to consider it as a form of joint forest management where the communities will get shamba and in return participate in forest protection, adequate funding of forest protection, KFS enforcement and CFAs in terms of remuneration and housing facilities (KFW, 2013). At this rate of reward it is clear that maintenance of the plots in the second year and third year will be carried out by Taungya farmers. Given that they themselves hire labour for some activities; it is reasonable to assume that they might do the work if the reward matched the market rate. An alternative method of payment would be on a per seedling, survival basis, pro rata. (M K Mc Call and M M Skutsch, 1993).

On the whole the per seedling method is more likely to give satisfactory results, although there will be cases of hardship due to drought and difficulties especially if farmers have land of unequal quality. (M K Mc Call and M M Skutsch, 1993) Growth of the planted areas under shamba system has been reported to be higher than unattended tree plantations (Pudden, 1953, Konuche and Kimondi, 1990). This is contrary to the earlier view, which claimed that growing trees under Taungya reduce the growth (FAO, 1967b)

In Ngare forest station, Nyeri, the forester noted that CFA participation was saving the government a lot of money due to reduced cost of seedling production, tree planting and tree protection. He indicated that a plot of 100 hectares of planting backlog, 70,000 seedlings were needed and these would have cost KFS about 1.4 million. However, KFS was only compensating the community with Kshs 300,000, hence saving Kshs 1.1 million (Kagombe, 1998).

The farmers who have been part of community Forest Associations have been very helpful in managing and protection of the forest "when we plant trees in the forest the farmers have played a key role in the forest positively in line with the Forest Act 2005 which mandates that we work hand in hand with communities' said Mr. Chege. He added that KFS and the farmers have been collaborating and encouraging the PELIS scheme which enables farmers to plant crops in forest area for three years as they tend seedling, this arrangement has been very beneficial and has ensured 100 percent survival of the planted tree seedlings (KFS, 2014).

Mr. J. Mwanzia, the project manager (GZDSP) expressed satisfaction by the efforts of the community through protection of forest particularly against forest fires. "As we were starting out, there were perennial forest fires as is common with forest during dry seasons and during those times communities offered us little and sometimes no help at all, but since

engaging them directly we have experienced total change of attitude as the communities are first to spot fire and put it off even before involving the forester “said Mwanzia (KFS, 2014). When farmers dig out the mature potatoes, they are cautious not to hurt any of the seedlings. They are growing the produce in state land within, the forest gazetted zone (R. Manyaka, 2015). We play a great role in conserving the environment around the area. And that is why when we plant the tree seedling, we work so hard to ensure they survive” she noted. (R.Manyaka, 2015). Trees grown under the PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI, (R.Manyaka, 2015).

2.6 Cost of Plantations Establishment and Forest Cover.

One of the key objectives of PELIS was to reduce the cost of plantation establishment that currently stand at Kshs 54,500 per hectare at three years using the pitting and spot weeding method as compared to about Kshs 30,350 per hectare under 'shamba' system (KFS, 2007). KFS will benefit from this scheme by saving money that would otherwise be used for land preparation and subsequent maintenance of the planted areas which will be utilized in other conservation programmes. (Chamashama, *et al.* 1992) observed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial income to the peasant farmers and reduction of forest plantation establishment costs.

Enabor (1979) observed that, introduction of Taungya system into the humid tropics was a response to various socio-economic factors. For example in Nigeria, a major objective was to solve the problem of high cost of forest regeneration. One benefit of shamba system is low cost of plantation establishment. Taking wage of kshs 80.00 and current task rates, costs of establishment of plantation per hectare compounded at 15% to the end of 30 years rotation, was found to be approximately kshs 277, 000 for NRC areas. This means NRC is critical to economic development of plantations (World Bank Supervision Report, 1996). In 1990's FD reduced its staff through the retrenchment programme, which had an aim of reducing government expenditure. This means only a skeleton staff remains in the forests stations (Kagombe, 1998). Tree planting is faster as opposed to natural regeneration but a more costly way of restoring forest cover. Forest recovery is a slow process and when time is important forest plantations are economically and ecologically good alternative (Lugo, 1992). The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the

labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The study by G C Monela,, *et al*., 1991 on analyzing the taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

The cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. The table below shows the cost of plantation establishment for each method by 2007. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. However, the system was abused such that prohibited farming tools were used like non-specified crops were planted and penalties for wrong doers were not honoured especially for those who rented out plots to outsiders who were not interested in conservation (FD, 2005). Effective cost/benefit sharing of forest resources e.g. through introduction of PELIS to reforest indigenous forest areas is a positive step. This could be adopted within the REDD+ framework (MFW, 2015).

Table 2.1: Task rates from FD (2005)

Activity	Total cultivation shs	Slashing shs	Slashing and spot hoeing shs	No preparation shs
Clearing	10,000	35,000	45,000	0
Staking out	1,500	1,500	1,500	1,500
Planting spos	1,500	3,000	3,000	3,000
Planting	1,500	1,500	1,500	1,500
Yr 1 tending	10,000	3,500	4,500	0
Yr 2 tending	10,000	3,500	4,500	0
Yr 3 tending	10,000	3,500	4,500	0
Total cost	**44,500**	**51,500**	**64,500**	**6,000**

Source: Task rates from FD (2005)

2.7 Livelihood Improvement and Forest Cover

Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and the survival of plantation trees, it has also provided other significant benefits such as making available arable land for the landless and contributing to food production. Plantation establishment and livelihood improvement scheme (PELIS) a modified form of non-residential cultivation that was practiced in earlier years in Kenya as a method of plantation establishment GOK, 2005; GOK, 2006;FAO, 2006). PELIS was initiated with the objectives of fully rehabilitating and protecting the forest and improving the livelihood of the forest adjacent communities (GOK, 2005). According to (Kafu, 2002) the expected benefits from PELIS were numerous. First, there would be increased forest cover, increased volume of water from the catchment areas, increased food production and there would be improvement in living standards of the communities living adjacent to forest due to increase in household incomes (GOK, 1994). PELIS is meant to improve economic gains of participating farmers while ensuring success of planted trees.

Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water

resources which loses its quality as forests condition worsens (MEA, 2005). Fresh water catchment and soil preservation are important inputs to agriculture and food production. FAO should also arrange with the government of Kenya as host of the FAO regional conference for Africa (March, 2008), to include the key role of forestry in achieving food security on the agenda. (Geller *et al.*, 2007).

V.K. Agyemen,2003, also noted that food crops, especially annuals such as plantain, Cocoyam and Vegetables were interplanted with determined trees species. The food crops were normally cultivated for three years, after which the shade from the trees impeded further cultivation of the crops. Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

Apart from successes observed through the MTS in the regeneration of degraded forest resources, the livelihood assets received by local people through the MTS intervention have led to significant increase in food productivity, income levels and general well-being of most households in all communities studied (Osei W and Eshun G, 2013). Interventions such as the MTS reveal that central governing agencies alone cannot have adequate capacity to combat deforestation and forest degradation or even monitor it. Local peoples' participation becomes a necessity for the implementation of the REDD+ intervention and related climate change mitigation measures to be effective (Osei W and Eshun G, 2013). Under the traditional taungya arrangements, Ghanian farmers had no rights to benefits accruing from the planted trees (Milton, 1994) and no decision making role in any aspect of forest management (Birikarang,2001).

A case study done in Njoro area East of Mau forest indicated that farming community in this area utilize the plantation area to grow food crops especially vegetables during the dry season. (B, Wangwe at el). Shamba system gives high return to farmers by close to Ksh 120,00 per hectare per year it creates employment to farmers and ensures food security.

(Kagombe, 2009). Forest management is important for people who gain a livelihood from the forest because people can only have a stable source of livelihood if forests are sustainably managed. In that way people can overcome their vulnerability based on forests (Hoogenbosch, 2010)

The project (GZDSP) has improved the livelihood of the communities living adjacent to forests through support of income generating activities (IGAs) which they depend on for survival. The model they engage in while rehabilitating degraded sites is Plantation Establishment and Livelihood Improvement Scheme (PELIS) which provided for communities to cultivate the forest area and plant crops for up to three years as they tend for the seedlings in the rehabilitated area. Mr. Kemau of the many beneficiaries said that the project activities enabled him buy a motorbike and purchase a ten acre piece of land in Gathiuru which he has started to construct. The communities utilize grazing rights, PELIS and fuel wood collection among other forest activities (KFS, 2014)

Kenya Forest Service Director, Mr David K. Mbugua on 10th may 2014 made a tour of Olbolossat forest, Nyandarua Zone to view the progress on areas of forest plantation under the CFA using PELIS that spell from 2009 to date. From the same unit of forest land a total of approximately 3,500 community forest Association members of which 2000 are able to generate profit from sale of crops while the remaining 1,500 benefits from grazing and other activities, have made Olbolossat success story. The next day the board visited Timboroa Forest station where they were received by members of the community led by CFA officials who took the board through the benefits they have enjoyed from their symbiotic relationship with the service in the form of PELIS.

In the nearby Nabkoi Forest station the board also saw the huge plantation backlogs that are typical of many areas where a shortage of resources caused backlogs (KFS, 2014). Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and survival of the plantation trees, it has also provided other benefits such as making available arable land for the landless and contributing to food production (Paul Okelo Odwori, Phillip M. Nyangweso and Mark O. Odhiambo, 2013). Under PELIS, CFA is allocated a piece of forest and where plantation trees are intended to be raised. The CFA shares it out among its members with each paying a small royalty. The farmers grow crops for food and for sale. In the second year (season) the farmers' plant preferred trees with the aid of KFS managers on the same piece of land.

In this way, farmers improve their food security, have some surplus for sale to get

income and their livelihood improve. (D. Walubengo and M Kinyanjui, 2010). It is a joy for farmers to benefit from PELIS as some people small pieces of land whose productivity is low can now generate enough profits to raise even wealthy families (R.Manyaka, 2015). Wanyoike said that since 2005, they have been farming on portioned acre producing high volume of potatoes and thus fetching good returns hence has significantly improved their living standards. “We have uplifted our living standards and we are so happy about it. Having a piece of land here (Aberdare Forest) to farm has created employment for us and we are making good profits” she said.

‘The MTS has been of immense benefit to the entire community, I could find majority of the youth in senior high school because their parents are now able to afford .Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small. Almost every member of this community involved in the MTS is able to grow more food stuffs for their household's consumption and for sale to earn some money to take care of their households. As for the trees we are willing to plant more and manage them well all we need from government is for us to have land and released to us on annual basis. Because we know that when trees are well taken care of ,they protect ourselves and the 40 percent benefit to MOTAG farmers who manage the trees well until maturity can support our children in the future EVEN when we are not alive" (Prince Osei *et al*., 2008).

Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars. “PELIS is offering communities an economic boom. Many CFAs are making millions from cultivating in the acres allocated to them” said Simiyu Wasike, deputy Director in charge of plantation and enterprise at Kenya Forest service. It a system promoting, plantation establishment, food security and better livelihood in the country and more than 185 CFAs exist in the country summing up the members exceeding 10,000 Wasike says (R. Manyaka 2015). Gerald Ngatia executive director for National Alliance for community Forest Association (NACFA), says successful PELIS is a major boosts to hundreds with of small scale farmer across the country. ‘Not only does PELIS create jobs for many but it greatly contributes to food security in the country. “Said Ngatia (R manyaka 2015).

2.8 Theoretical Framework

This study related two theories i.e. forest transition theory and environmental Kuznets curve theory.

2.8.1 Forest Transition Theory (FT)

The theory describes a sequence over time where a forested region goes through a period of deforestation before the forest cover eventually stabilizes and start to increase. This sequence can be seen as a systematic pattern of change in agricultural and forest land rents overtime. Increasing agricultural rent leads to high rate of deforestation. In describing how forest cover changes through the development phases of a country, this concept of forest transition is useful in depicting such changes. In that regard, the forest transition (FT) model describes the overall human induced changes of forest cover overtime and basically presents the combined effect of various drivers of on a national scale. The concept was proposed and articulated by Mather (1992) and later expanded by Rudel (2005) and (Kauppi *et al.*, 2006).

The model basically shows the transition in which a country with 40% forest cover goes through phases of decreasing forest cover through human activities till a period of maximum decrease before a country realizes that it can no longer afford to lose more forest cover and at which time, it begins to stop further net loss of forest cover and put in policies and measures to increase forest cover, in the case of Kenya the policy is PELIS. Graphically the trajectory is described at the national level by inverse J-shaped curve overtime. Furthermore the entire inverse J-shaped curve can be broken into four phases namely: pre-transition, early transition, late transition and post transition phase. These phases generally represent a time sequence of national development (Hnosuma *et al.*, 2012).

In Africa subsistence agriculture remains the dominant driver but the effect of commercial agriculture is likely to increase in early transition. Countries such as Angola, DRC, Zambia and Mozambique with respect to forest degradation, logging accounts for 52% fuel wood and charcoal 31%, fire 9% and livestock grazing 7%. The Kenya forest service can use its position on the curve for purposes of policy advocacy for the forest sector in general and for REDD+ in particular. Honosuma *et al.*, (2012) observed that the phases of transition are associated by drivers of varying significance as listed herein;

1. Agricultural expansion dominates the early and the late transition phases.
2. Fuel wood and fires- become more dominant in late and post transition phases.
3. Subsistence agricultural- fairly stable over all phases.

4. Urban expansion-largest in the post transition phase.

In general, nature the study notwithstanding, the study by Honosuma *et al*. 2012 places Kenya in the late transition phase in generalizing transition curve.

2.8.2 Environmental Kuznets Curve Theory

The second theory that also relates to forest cover is environmental Kuznets curve that contends that a U-shaped relationship exists between environment quality and economic development. The theory relates forest cover as key indicator of environmental quality and income levels.

2.8.2.1 Forest and the Natural Environment

Forests have been a source of life from time immemorial. A part from being the basis for a variety of wood and non-wood products and services forests are home to many forms of life and an essential role environmentally, including climate regulation, carbon recycling, bio diversity preservation and soil and water conservation. Biodiversity is widely recognized as a major source of sustainability, indicator may be identified to help detect human impact on nature including the health of ecosystem, the functionality of watersheds and so on.

2.8.2.2 Environmental Quality and Economic Well being.

On the basis of framework of Kuznets (1955) proposition asserts that economic growth may be harmful to the environment before reaching a certain stage but becomes conducive afterwards. Hence the relationship assumes a U-shaped. (Arrow *et al*. 1995).. The curve indicates that as the economy grows, environmental degradation increases up to certain level after which environmental quality improves. This means that at low income levels, environmental quality tends to decline along with economic growth, but ultimately improves as income levels rise beyond a threshold. The U-shaped relationship is dictated by the ability to spend on environmental amenities implying that wealthy countries have lower levels of environmental damage because they can afford to pay for environmental improvement, whereas poor countries cannot afford to emphasize amenities over material well-being.

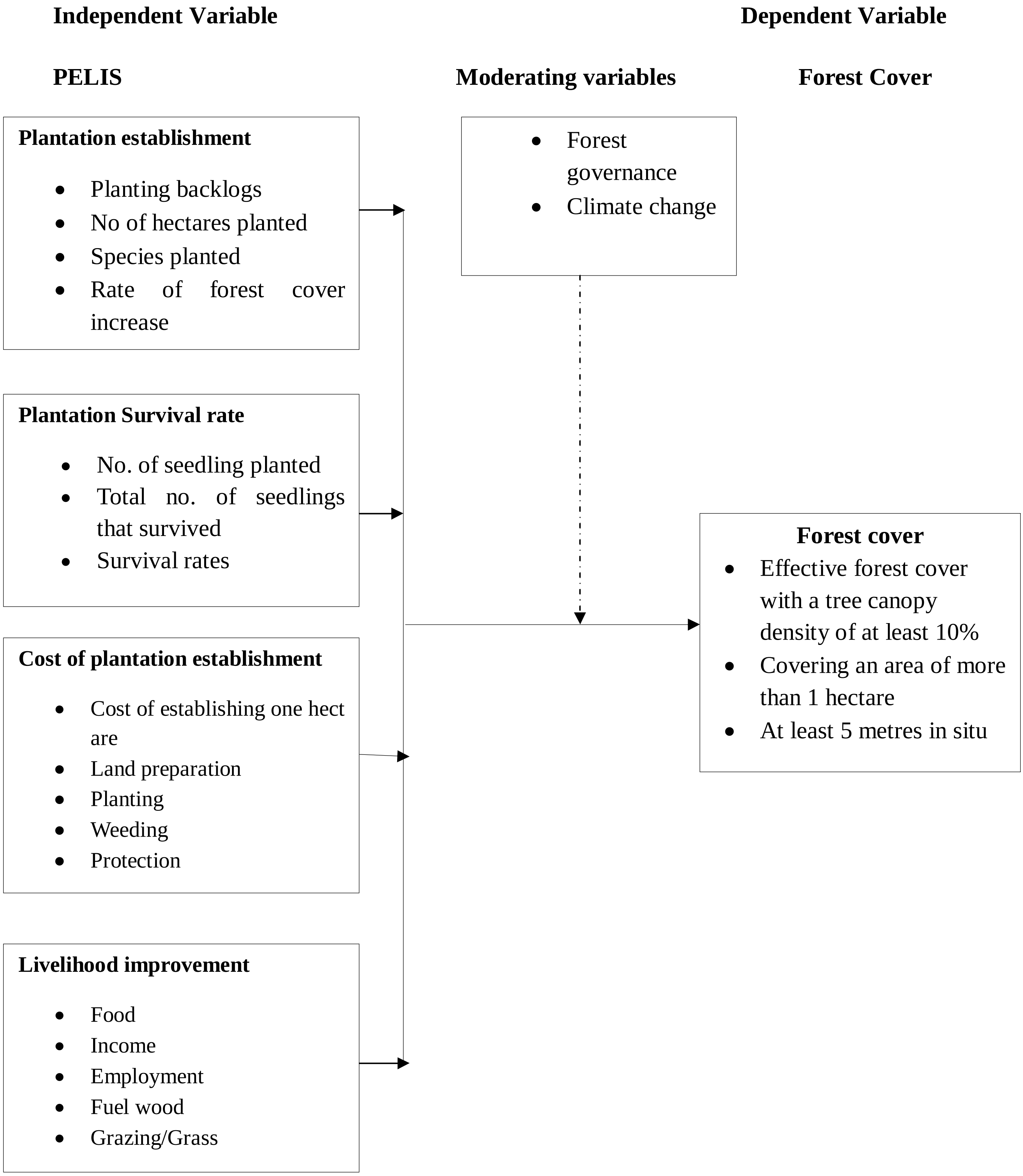
2.8.2.3 Is Forest Cover Related to Income Levels?

Human beings depend on forests for a variety of purposes. Population growth results in higher demand for forest based products and services. Therefore, it is reasonably to

postulate that population increase is a fundamental driving force of change in forest cover. (Mather *et al*. 1999) suggest that there is a theoretical basis for linking long term trends in forest use with economic developments including the emergence of forest transition as a society's income rises. Change in the state of the forest is subjected to a certain set of appropriate and constraints and income levels. From the perspective of developing countries, unless the gap between global diversity benefits and the needs of local people is narrowed the required economic growth will occur at the expense of much of the planets biodiversity (Fuentes-Quezada, 1996).

2.9 Conceptual Framework

Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced in the Kenya's forestry sector to specifically alleviate planting backlogs, increase plantation survival rate, reduce cost of plantation establishment and improve the livelihood of the adjacent communities through food security. Its overall key objective was to increase the forest cover. The table below shows the two variables and their indicators.



(Source: Researcher, 2015)

Figure 1: Conceptual framework

Independent variable is PELIS while dependent variable is forest cover in this study. There are four factors that influence forest cover, and they include; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. The PELIS indicators would be the number of hectares planted, plantation survival rate, the cost of plantation establishment and the number of bags of maize and potatoes harvested. While on forest cover the indicator would be the area under forest cover in percentage. However, there are some other external factors that may behave like independent variable and has contributory effect on the relationship between independent and dependent variables. They include; forest governance and climate change factors. These factors could be termed as moderating variables.

On forest governance, if there are no proper rules, regulations, policies and code of ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, and prolonged dry spell. These will eventually lead to forest destruction and degradation hence forest cover loss.

2.10 Gaps in Literature Review.

The literature review on PELIS covered by this study has largely focused on its influence on food security to the forest adjacent communities and availing arable land to the landless. A wide knowledge gap of PELIS influence on forest cover is conspicuously missing and if available but only by mentioning. It is on this backdrop that this study will come handy for the policy makers in making informed policies and decisions besides ensuring sustainable production of the various forest products and services to the forestry sector players in the country.

MFW (2012) identified lack of clear policy on cost and benefit sharing that is not covered in the current Forest Act 2005. This is hindering afforestation and protection efforts by the key stakeholders as they feel they are short changed. Need for review of technical orders on spacing to increase the time farmers cultivate plots before canopy closure. Lack of stringent harvesting procedure is also escalating over logging, this include lack of felling and plantation establishment plans or look warm implementation in areas where they exists. (MFW, 2012).Lack of incentives to CFA members involved in PELIS make them less accountable to the programme rules and regulations. Conflicting sectoral policies e.g. Water

Act, Agricultural Act and EMCA, 1999 Act on wetlands protection. All these needs further research so as to ensure that all these bottlenecks are addressed.

Table 2.2: Knowledge Gaps

Thematic area	Author (s)	Method	Main findings	Knowledge Gaps
Influence of plantation establishment and livelihood improvement scheme on livelihood of Gaithiuru forest, Nyeri.	Mwatika N M (2013)	Descriptive research design that targeted CFA member	Study found that PELIS had a positive influence on livelihood of forest adjacent communities. The scheme diversified sources of livelihood, enhanced social and human capital.	The researcher did not study the influence of PELIS on forest cover. This study will explore how PELIS contribute to forest cover through enhanced area established with plantation.
Forest reclamation, REDD readiness and community livelihood sustainability. Assessing the viability of modified Taungya system as a decentralized Nature governance strategy.	Prince Osei Wusu Adjei and Gabriel Eshun (2008)	Survey method that targeted a total of 150 respondents in four forest fringe communities in a district in Ghana about their own forest and how it is governed.	Community participation in forestry decisions through the MTS enhances community resilience to combat climate change through improved community forest cover and livelihood.	The research targeted on modified taungya system as adecentralised nature governance strategy. This study will focus on the influence of PELIS on forest cover through plantation establishment, plantation survival rate and costs of plantation establishment.
Plantation establishment in Kenya – The shamba system case study	Joram K Kagombe and J M Gitonga (2005)	Survey method that targeted selected five districts	Total cultivation for plantation establishment is expensive but gives the highest survival and growth rate .	The study never focused on the influence of NRC on forest cover. This study intends to determine how much area has been established through use of PELIS

Challenges facing forest plantation establishment through shamba system; the case of Mucheene forest.	Ikiara, Isaac G (2010)	Survey method that targeted cultivators of six CBOs	There was adherance to the shamba system policy guidelines and community participation.	The study did not establish the influence of plantation establishment, plantation survival rates and cost of plantation establishment on forest cover.
Alleviating Food Insecurity and Landlessness Through PELIS in Kenya	Paul O. Odwori, Phillip M. Nyangweso and Mark O. Odhiambo (2013)	Purposive sampling was used to identify forest zones that practice PELIS in Kenya	PELIS contribute up to 2,049 hectares of arable land to the landless and up to 3 million bags of maize	The researcher did not focus on the influence of PELIS in increasing forest cover hence basis of this study.

2.11 Summary of Literature Reviewed

The study gathered literature from a wide range of authors whose studies were mostly based on the influence of PELIS on the livelihood of the forest adjacent communities but not on forest cover. PELIS has a number of components, some of the key components highlighted in this study include: plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. During literature review the four components were found to influence forest cover. With regard to the influence of plantation establishment on forest cover the literature reviewed showed that indeed there is influence but was not discussed at length. On influence of survival rate on forest cover many authors established that well weeded, fertilized and protected plantations improved survival rates. Little literature was established with regard to the influence of cost of plantation establishment on forest cover, as farmers were providing labour for free from land preparation to protection and this was made possible because farmers were tending their crops too. Most researchers reviewed literature on the influence of PELIS on livelihood improvement of the forest adjacent communities but not livelihood improvement on forest cover. It is therefore important that the literature reviewed in this study will go a long way in bringing out the link between PELIS and forest cover.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter entails research design, target population, sampling design / procedure, sample size, data collection instrument, data collection procedure, measurement of variables, reliability test, and validation of instrument, data analysis, anticipated outcome and ethical considerations.

3.2 Research Design

This study explored survey research design. .It uses primary and secondary sources and qualitative data sources e.g. diaries, official records, reports etc. Survey is the systematic means of collecting information from people that generally uses a questionnaire (Grewal and Levy, 2009). Given that the study largely relied on the secondary data from the government offices and administering of interview schedules and questionnaires to the forest managers and the CFA members respectively hence it was necessary to use the research design.

3.3 Target Population

Target population was 6521 which included 6515 CFA members and 6 forest station managers. The study focused on plantations established 2001-2007, without PELIS and plantations established 2008-2014 with PELIS.

Table 3.1: Target population

Strata	No of CFA members	No of forest station managers	Total
Kapsaret	403	1	404
Cengalo	1650	1	1651
Nabkoi	1804	1	1805
Kipkurere	852	1	853
Timboroa	1406	1	1407
Lorenge	400	1	401
Sub –Total	**6515**	**6**	**6521**

3.4 Sampling Procedure and Sample Size

3.4.1 Sampling Procedure

Simple random sampling method was used in the two population groups because it is considered simple, most convenient and bias free. Every member of the population has equal and independent chances of being selected as respondents (Frankel *et al*, 2000). Sampling is a procedure of selecting a part of the population on which research is to be carried out, which ensures that conclusions from the study can be generalized to the entire population. Since the forest station managers were few, the researcher used non probability technique which is purposive sampling design to select the six forest station managers. (Leedy, 1993) observed that nothing comes out at the end of a long and involved study that is any better than the careful selection of the population using random sampling and stratified random sampling.

3.4.2 Sample Size

Given that the target population is less than 10,000 hence to calculate the final sample (Nassiuma 2000) sample size formula will be used. According to (Nassium, 2000) in most surveys , a coefficient of variation is the range of 21% ≤30% and standard error in the range 2% ≤ e ≤ 5% is usually acceptable. Therefore the study will use a coefficient variation of 30% and a standard error of 2%. Nassium (2000), gives the formula as follows; $n=Nc^2/c^2+(N-1)e^2$. Where; n= Sam ple size, N= population, c= covariance, e= standard error.

$$n = \frac{6515(0.3)^2}{0.3^2+(6515-1)\ 0.02^2} = 218.$$

Target population sample size is 218.

By using this formula a sample size of 6 and 218 for forest stations and CFA members will be used respectively. Below, is the table summary for target population in each study area and corresponding sample taken from each area. The study will use Neyman (2000) formula for stratum sample size allocation, Nh - (Nh/N) * n where sample size for stratum h, Nh= population size stratum h, N = total size of population, n= total sample size.

Table 3.2: Sample size for target population

Strata	CFA Members	Sample Size	Forest Managers	Sample Size	Total Sample Size
Kapseret	403	14	1	1	15
Nabkoi	1650	55	1	1	56
Cengalo	1804	60	1	1	61
Kipkurere	852	29	1	1	30
Timboroa	1406	47	1	1	48
Lorenge	400	13	1	1	14
Sub-Total	**6515**	**218**	**6**	**6**	**224**

Random sampling method was used to sample the CFA members for each forest statio n .This was done by assigning random numbers to them.

3.5 Data Collection Instruments

The study employed both primary and secondary sources of data, which included questionnaires, interview schedule and personal observations. In the case of secondary data, office records like statistical reports, scholarly journals, thesis, diary, and pamphlets, were used as well as Worldwide Web, text books, newsletters and magazines. Questionnaires as a primary source was used for data collection from the CFA members and interview schedules were used for forest station managers .A questionnaire is a form that features a set of

questions designed to gather information from respondents and whereby accomplish the researchers' objectives (Grewal and Levy,2009).

The questionnaires were structured. It is relatively economical method in cost and time, of soliciting data from a large number of people and the time for checking on facts and pondering on questions can also be taken by respondents, which tend to lead to more accurate information (William, 2005). Each item in the questionnaire is developed to address specific objectives, research questions or hypothesis of the study. The respondent is expected to react usually in writing. It assists in collection of information over a short period of time when time is a limiting factor.

The researcher personally together with competent assistants administered the questionnaires and the interview schedules so as to be assured of relatively uniform mode of questioning and questioning and subsequent respondents. The questionnaires were in two parts, Section A was about demographic information and Section B was about CFA food production activities through PELIS and plantations establishment 2001-2014. The study also employed face to face interview and personal observations from the six forest station managers to get clarity on some secondary data gathered from the office records. The reason for using interviews was that they are easy to administer since questionnaires are already prepared .The investigator follows a rigid procedure and sought answers to a set of pre-conceived questions through personal interviews (Kothari, 2004).

They also eliminate many sources of bias common to other instruments. This is because questions asked are usually confidential between the researcher and the respondent. Interviews clarify points that are not clear, collected from key informants by use of interview schedules. Interview schedule is important because it helps eliciting in depth responses that may enable deep understanding of the research problem. The interview schedules are comprised of A which is about demographic information while section B up to F about the four study objectives. Personal observations will also be employed in assessing the status of the plantations. This is where the researcher uses all the senses to perceive and understand the experiences of interest. It gives firsthand experience without respondents information as it occurs, explains topics that may be uncomfortable to respondents and notice unusual aspects. The researcher uses an observation checklist to record what he observes during data collection.

3.5.1 Pilot Testing of Instruments

A pilot study was carried out at one of the six forest stations and it's CFA. This was purposely to confirm the reliability and validity of the research instruments .The researcher also verified that ambiguous information was removed while deficiencies and weaknesses were be noted and corrected in the final instruments (Croswell & Miller; 2000). The main aim was to ensure clarity and suitability of the instruments that were used in the study. Reliability and validity is about usability of the instruments as it is about ease with which instruments can be administered, interpreted by participant and scored/interpreted by researcher. Usability considerations include how long it will take to administer, are directives clear, how easy is it to score etc.

3.5.2 Validity of Research Instrument

It is the extent to which an instrument measures what it is supposed and performs as it is designed to perform. This involves collection and analysis of data to asses accuracy of an instrument. It is prudent to use instruments from previous studies to ascertain content validity. It is one that has been developed and tested several times. It is about appropriateness of the content of an instrument. It should measure what one wants to know. To confirm this both the questionnaires and the interview schedules were tested by administering the same.

3.5.3 Reliability of Research Instrument

It refers to stability or consistency of measurement; that is whether or not the same results would be achieved if the test of measure will be applied repeatedly (Someh and Lewin, 2007) Reliability test of the instruments was done using cronbach alpha co-efficient. Nunally (1967) suggested that the minimal uptake reliability of 0.7 is recommended. To ascertain the reliability of the questionnaires, the researcher administered 10 questionnaires and two interview schedules for two CFA groups and two forest managers respectively. The modes of responses to the instruments were consistent and even time taken to answer the same.

3.6 Data Collection Procedures

The process of data collection commenced once the necessary certifications had been completed. The researcher sought permission from National Council for Science and Technology and finally got authority from the County Commissioner, Eldoret to carry out

research in the identified area. The researcher personally with the assistance of competent assistants administered the research instruments to the respondents after familiarization and informing the respondents of the purpose of study. Appointments were booked for various dates for data collection. The interview schedules for forest station managers were personally administered by the researcher. He also personally together with the assistants distributed the questionnaires and the completed instruments were verified and collected from the respondents.

3.7 Data Analysis

The data collected from both primary and secondary sources were checked for completeness, accuracy and relevance. SPSS was used to analyze the data. Descriptive statistics were used in analysis and presented in tables, frequencies and percentages. Also used were measures of central tendencies and dispersion where applicable.

3.8 Operationalisation of Variables in the Conceptual Framework

Table 3.3: Operationalization of Variables

Objective	Indicator	Measurement Scale	Tools of Analysis
To establish the influence of plantation establishment on forest cover in Uasin Gishu county.	-No of hectares established -No of species planted	Ratio Nominal Ordinal	Means, frequencies and percentages
To determine the influence of plantation survival rate on forest cover in Uasin Gishu county.	-No of seedlings established -Total number of seedlings that survived	Nominal Ordinal	Means, frequencies and percentages
To investigate the influence of cost of plantation establishment on forest cover in Uasin Gishu county.	-Cost of establishing one hectare	Ratio Ordinal Interval	Means, frequencies, percentages and standard deviation
To assess the influence of livelihood improvement on forest cover in Uasin Gishu county.	-No of bags of maize produced per acre -No of bags of potatoes produced per	Nominal Ratio Ordinal	Means, frequencies, percentages and standard deviation

	acre -No of bags of beans produced per acre -No of farmers who benefit from employment opportunities created -No of farmers who collect fuel wood from forest -Amount of money earned from sale of crops -No of farmers who cut grass/graze in the forest	

Source: Researcher (2015)

3.9 Ethical Considerations

To ensure compliance with ethical consideration the researcher sought permission from the relevant authorities. The respondents were given introductory letter for their permission to participate in the study. The names of the respondents were not disclosed unless on mutual agreement. All confidentialities of the respondents were not disclosed to the third party. The researcher observed honesty and practiced integrity (Shamhoo and Resnik, 2009). The data results, methods and procedures and probabilities were honestly reported by the researcher .Biasness was avoided in data collection, analysis and interpretations. The researcher avoided careless errors and negligence, being critical in examination of findings so as to keep good records of research activities.

CHAPTER FOUR

4.0 DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

Chapter four gives detailed data analysis, presentation and interpretations of the study findings. Data was collected and analyzed through the use of descriptive and inferential statistics. The data was then presented in tables. The discussion of the findings enabled the researcher to make inferences on the influence of PELIS in promoting forest cover. The study findings were then linked to the researcher's opinion in relation to the existing knowledge for close interpretation and discussion. The chapter is organized into sections beginning with presentation of the respondents' background information and the subsequent sections have been organized to follow the research objectives. There were a total of 224 people including 6 forest station managers and 218 CFA members involved in this study through the use of questionnaires and interview schedules.

4.2 Respondents Return Rate

4.2.1 Respondents Return Rate for Forest Managers

All the six forest station managers completed the interview schedules which represented 100% response rate. This response rate was enough to give the researcher confidence to carry on with the study. Table 4.1 shows the distribution of the response return rate amongst the six forest managers.

Table 4.1: Response rate for Forest Managers

Respondents	Sample	Response rate	Percent (%)
Kapsaret	1	1	100
Nabkoi	1	1	100
Cengalo	1	1	100
Kipkurere	1	1	100
Timboroa	1	1	100
Lorenge	1	1	100
Total	**6**	**6**	**100**

All the six interview schedules were returned filled. This very positive response could have been due to the use of purposive sampling technique that ensured all the six forest managers responded to the interview schedule as this was a small sample size. A wealth of experience and knowledge by the forest managers also contributed to the excellent response. The personal administering of the interview schedule by the researcher also significantly influenced the impressive return rate. Brief and precise interview schedules enabled the managers not to fill bored.

4.2.2 Respondents Return Rate for CFA Members

All the 218 CFA members sampled completed the questionnaires which represented 100% response rate. This was significant to allow the researcher to continue with the study. The table below shows the respondents return rate for CFA members..

Table 4. 2: Response Rate for CFA Members

Respondents	Sample	Response rate	Percent (%)
Kapsaret	14	14	100
Nabkoi	55	55	100
Cengalo	60	60	100
Kipkabus	29	29	100
Timboroa	47	47	100
Lorenge	13	13	100
Total	**218**	**218**	**100**

The researcher employed five competent assistants in each forest station who assisted in administering of the questionnaires to the CFA members. This enhanced coverage hence the positive response. The use of brief and precise questionnaires ensured the respondents were not fatigued. The questionnaires were also semi structured hence easier to comprehend and took little CFA members time. This response rate was considered reliable to make conclusions from.

4.3 Demographic Background of Respondents

4.3.1 Forest Managers

4.3.1.1 Level of Education

Given that education is a prerequisite for effective sustainable management of forest resources, the study established the education levels of the forest managers as 3(50%) had diploma as highest education level, 2(33.3%) had undergraduate education and 1(16.7%) had post graduate education. The mean number of years of working experience was 4.4. Table 4.3 indicates the education levels of the forest managers.

Table 4.3: Highest education level

Education level	Frequency	Percent
Diploma	3	50
Undergraduate	2	33.3
Postgraduate	1	16.7
Total	**6**	**100**

Education level and experience are critical tools in sustainable forest management as the manager is able to make sound decisions, interpret and implement policies and regulations that govern forestry practice). It also helps in efficient and effective management of resources both human and material. It is on this strength that the government is encouraging employees to scale up their level of education through gaining of more skills, knowledge and experience by offering study leaves and scholarships.

4.3.1.2 Age Distribution

The table below shows the age distribution of the forest managers. It was observed from the study findings that majority of them are in the age bracket of Over 50 years at 3(50%), 41-45 years 2(33.3%) and 46-50 years 1(16.7%).

Table 4.4: Age Distribution of Forest Managers

Category	Frequency	Percent (%)
18-25 years	0	0
26-30 years	0	0
31-35 years	0	0
36-40 years	0	0
41-45 years	2	33.3
46-50 years	1	16.7
Over 50 years	3	50
Total	**6**	**100**

Nzuve, (2010) observed that one of the key ingredients to an organizations strength and growth is having the right people in the right place at the right time. From the findings it was noted that majority of the forest managers were aging as there was none in the age bracket of 40 years and below. This poses a threat to succession and continuity of the organization. Positively age reflects the experience that one has gained over the years which is significant for increased effective and efficient productivity. There is likelihood of low productivity as the aging employees would tend to focus more on his forthcoming retirement as opposed to concentrating his efforts in working towards the achievement of the organization objectives.

4.4 Demographic Background of Community Forest Association Members.

4.4.1 Gender Distribution

Gender distribution is vital to forest management and conservation as each gender is well suited for specific activities. It was established from the study that 130(59.6%) CFA members were females while 88(40.4%) were males. Table 4.5 below depicts gender distribution for the CFA members.

.Table 4.5: Gender Distribution

Category	Frequency	Percent
Male	88	40.4
Female	130	59.6
Total	**218**	**100**

The study showed that the biggest population of the CFAs are females, who participate in PELIS, culturally the societies expects females to be in the forefront to ensure that food is available to the children and the family at large hence the increased percentage. It is them who spent most of the time with the children as opposed to the males.

4.4.2 Age Distribution

Most forestry activities are labour intensive especially PELIS. This would mean that energetic people take the forefront. It was established that majority of the CFA members were in the age bracket of 36-40 years with 112(51.4%), 41-45 years 30(13.8%), 46-50 years 25(11.5%), over 50 years 21(9.6%), 31-35 years 20(9.2%), 26-30 years 10(4.6%) while there was no representation in age category of 18-25 years. Their mean age (in years) was 38.4 with a range of (min 18, max 72). Table 4.6 shows the age distribution of the CFA members.

Table 4.6: Age Distribution of CFA Members

Category	Frequency	Percent
18- 25 years	0	0
26-30 years	10	4.6
31-35 years	20	9.2
36-40 years	112	51.4
41-45 years	30	13.8
46-50 years	25	11.5
Over 50 years	21	9.6
Total	**218**	**100**

It is evident from the study findings that majority of the farmers are at their prime age hence able to effectively use their energy in food production for their families. It is also important to note that at age 41 years the number of farmers starts to decrease, this could imply subsequent decline in energy and vigour. There is also low representation in ages between 18-35 years, as this could also imply that this youthful age; the youth are engaged in either schooling or other sources of income.

4.5 Plantation Establishment and Forest Cover

4.5.1 Planting backlogs

A huge planting backlog is an indicator of large unstocked plantation areas. There was a total backlog of 6066 hectares as at 2008 while as at 2014 there was 1,935.6 hectares. This represented 18.8% (2008) and 6 %(2014) respectively. The total forested area was 26,141.9 hectares as at 2008 and 30,272.3 hectares as at 2014 as indicated in table 4.7 below illustrates the planting backlogs.

Table 4.7: Planting Backlogs

Year	Total forest Area (Ha)	Forested are a (Ha)	Backlog (Ha)	Percent
As at 2008	32,207.9	26, 141.9	6066	18.8
As at 2014	32,207.9	30,272.3	1,935.6	6

The findings from the study established that planting backlog reduced from 18.8% to 6% as at 2008 and as at 2014 respectively. This represented a decrease of 60% in planting backlog. This development could be attributed to the influence of PELIS as a strategy in increasing forest cover. As the CFA members are allocated plots to cultivate their crops they also assist in planting and weeding tree seedlings alongside accepted agricultural crops.

4.5.2 Area Established through PELIS

The table below covers the area that was established 2008-2014 when PELIS as a strategy was introduced at the forest stations. The study shows that there was a steady increase in area of plantations established using PELIS strategy i.e. 2008(4.3%), 2009 (6.96%) ,2010(11.75%) ,2011(18.46%) 2012(12.78%),2013 (21.18%) and 2014 (24.56%).

Table 4.8: Area Established through PELIS

Year	Area Established (Ha)	Percentage (%)
2008	177.6	4.30
2009	287.4	6.96
2010	485.4	11.75
2011	762.6	18.46
2O12	528	12.78
2O13	874.8	21.18
2014	1014.6	24.56
Total	**4130.4**	**100**

It was noted from the analysis that a total of 4130.4 hectares was established with PELIS from 2008-2014. It is only 2012 (12.78%) which revealed reduced establishment area that could have been due to anticipated general election for 2013, prolonged drought and transfer of forest managers. The planting backlogs stood at 1935.6 hectares as at 2014 that could have been due to continued plantations felling that do not correspond to plantations establishment rate following the lifting of the logging ban in 2012 by the government and lack of approved felling plans as indicated in table 4.2 above. The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation. (O.A. Ndomba *et al.*; 2014). V. K. Agyeman at el., 2003, established that about 78 percent of Ghana current total area of commercial public and private forest plantations

of 35, 000 ha were established using the taungya system.

Hoefsloot *et al.*, (2011) observed that although Shamba system existed in the years 2007 and below, it was abused by the implementers and never had stringent rules and regulations to govern it as PELIS does. However, as part of conservation efforts to replenish the forest cover, members of the CFA are supplied with certified seedlings, which they plant in the allocated portions and tend to them during cropping season (R.Manyaka, 2015). The area under PELIS increased from 2933 hectares in 2010/2011 financial year to 9939 hectares in 2012 /2013, according to the statistics by KEFRI (R Manyaka, 2015). The official said the scheme is a driving force in replenishing the forest cover while giving communities an opportunity to enjoy the forest economic benefits (R. Manyaka, 2015). Mr. Mwanzia the project manager (GZDSP) noted that the issue of ownership by community has improved rehabilitation efforts as there are fewer planting backlogs (KFS, 2014).

4.5.3 Major Species Planted

The table below shows the major tree species grown in the state forests. The study findings revealed that the species compositions were: *Cupressus lusitanica* 2,424.5 ha (58.7%), *Pinus patula* 1,086.3 ha (26.3%), *Eucalypts* 375.9 ha (9.1%) and indigenous 243.7 ha (5.9%).

Table: 4.9: Major Species planted

Species	Area established (Ha)	Percentage (%)
Cupressus lusitanica	2,424.5	58.7
Pinus patula	1,086.3	26.3
Eucalypts	375.9	9.1
Indigenous	243.7	5.9
Total	**4130.4**	**100**

The major species grown for industrial plantations and conservation in all the six forest stations included: *Cupressus lusitanica*, *Pinus patula* and *Eucalypts* species, all exotic. On conservation front, the common indigenous species included *Podocarpus falcatus*, *Podocarpus latifolius*, *Juniperus procera*, *Vitex keniensis*, *Olea* spp etc.The indigenous species are planted along catchment areas, degraded sites and for biodiversity conservation.

4.5.4 Rate of Increase in Forest Cover due to PELIS

The total forested area of the six forest stations was 32,207.9 hectares. Given that the total area established with plantations by 2014 was 4130.4 hectares, it therefore means that the percentage increase in forest cover during the PELIS period was 12.8%. Comparatively the percentage increase in forest cover without PELIS was 7.8%, this was from a total area of 2502.4 hectares of plantation established. Table 4.9 below illustrates the rate of increase in forest cover as a result of PELIS.

Table 4.10: Rate of increase of forest cover due to PELIS

Category	Total forest area (ha)	Area planted (ha)	Percent
As at 2008 (NO PELIS)	32,207.9	2,502.4	7.8
As at 2014 (PELIS)	32.207.9	4,130.4	12.8

According to the study findings on table 4.7 on the influence of plantation establishment on forest cover, there was an increase of 12.8% of forest cover following the planting of 4130.4 hectares of planting backlogs as at 2014. This therefore means indeed PELIS significantly contributed to forest cover as CFA members were allocated plots in clear felled areas and other open suitable areas to cultivate their crops; they too assisted in planting tree seedlings in the plots and tended them until canopy closure at about three years. By doing this KFS was able to realize plantation establishment of large areas as indicated by the study findings. As the farmers provided labour freely for land preparation, land cultivation, pitting, planting, weeding and protection. A well managed PELIS can significantly contribute to attainment of 10% forest cover by 2030 as envisaged in the vision 2030 and the constitution. Comparatively, the areas that were established without PELIS were low i.e 2502.4 (7.8%) hectares compared to 4130.4 (12.8%) hectares, area established with PELIS during the same period. This could have been low due to grassland planting that emphasized spot hoeing and spot weeding. There were also subsidy from multinational companies like Timsales, Pan Paper Mills and Raiply as they would provide funds for reforestation programmes of cleafelled areas. However, these have since stopped.

According to (FRA, 2015), the rate at which the world is losing its forests has been halved, but an area of 129 million hectares of South Africa has still been lost since 1990, UNs Food and Agriculture Organization report says. Improvement has been seen around the globe, even in the key tropical rainforests of South America and Africa. "FRA, 2015 shows a

very encouraging tendency towards a r education in the rates of deforestation and carbon emissions from forests and increases in capacity for sustainable forest management", said FAO director general Jose Graziano da Silva. Halting deforestation is a key focus of UN negotiations for a global pact limit disastrous climate change caused by greenhouse gas emissions.

The net annual rate of loss which takes into account the planting of new forests has slowed from 0.18 percent in the 1990s to 0.08 percent over the last five years. Planted forest area has increased by more than 110 million hectares since 1990 and now accounts for seven percent of the world's forest area (FRA, 2015). M Nicholson, 2000 observed that Kenya's forest cover has tripled over the last 10 years increasing allaying fears of massive environmental degradation. According to government statistics released in March 2012, forest cover had risen from a low of 1.7 percent in 2002 to 5.9 per cent. The forest in both NP and FR which had been seriously degraded is now showing signs of recovery, pole stage trees are beginning to emerge from the climber tangles even where assisted regeneration had not been done earlier. (R Manyaka, 2015).

4.5.5 Plantation Establishment without PELIS

The study findings indicate that a total of 2502.4 hectares was established between 2001-2007 .It can be noted that is relatively low compared to the area that was established through PELIS 2008-2014 which was 4130.4 hectares. The largest area of plantation established was 474.6 hectares representing 18.97% in 2001 while the lowest was in 2002 with 199.8 hectares representing 7.98%. Table 4.10 below shows the plantations establishment without PELIS.

Table 4.11: Area Established without PELIS

Year	Hectares Established (Ha)	Percentages (%)
2001	474.6	18.97
2002	199.8	7.98
2003	372.6	14.89
2004	455.4	18.20
2005	328.8	13.14
2006	279.0	11.15
2007	392.4	15.68
Total	**2502.4**	**100**

The areas that were established without PELIS were low i.e 2502.4 (7.8%). Lack of funds from the government for reforestation programmes of clear felled areas was inadequate and this could have resulted to low plantation establishment coverage

4.6 Plantations Survival Rates and Forest Cover

4.6.1 Survival Rates of Plantations Established Through PELIS

The table below indicates the survival rates of plantation established through PELIS. From the study findings, the mean survival rate of plantations established with PELIS was highest in 2008(84.7%) and the lowest in 2013 (64.2%) as shown in table 4. 11. The study found that the survival rates of plantations established with PELIS were higher at 84.7% while without PELIS was 50.3%. The mean survival rate for plantations established with PELIS was 75.1%.

Table 4.12: Survival rates of plantations established through PELIS

Year	Area (Ha)	No. Of Seedlings Planted	No. Of Seedlings That Survived	Survival Rate (%)
2008	177.6	284,160	240,684	84.7
2009	287.4	459,840	338,442	73.6
2010	485.4	776,640	597,236	76.9
2011	762.6	1,220,160	920,000	75.4
2012	528	844,800	631,910	74.8
2013	874.8	1,399,680	898,595	64.2
2014	1014.6	1,623,360	1,245,117	76.7
Total	**4130.4**	**6,608,640**	**4,871,984**	**75.1**

The study findings could be attributed to the reduced competition for water and nutrients due to weeding, fertilization and low pruning done by the PELIS farmers. As the farmers weed their plots they too weed the young trees. As they apply fertilizers to their crops young trees too benefit from speel overs to the rooting system of trees. All these activities together with the protection the farmers provide to their crops, the young trees too are protected from straying livestock and wildlife hence increased survival rates.

Trees grown under PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI (Manyaka R, 2015). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012). The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004).

4.6.2 Survival Rates of Plantations Established without PELIS

The table below shows the various plantation survival rates in different years. The highest mean survival rate recorded was 50.3 %(2007) and 50.3 %(2005) while the lowest was 29.6% (2002). On average the survival rate for all plantations established without PELIS was 45.2%, table 4.12 below.

Table 4.13: Survival rates of plantations established without PELIS

Year	Area (HA)	No of Seedlings Planted	No. of Seedlings Survived	Survival rate (%)
2001`	474.6	759,360	325,006	42.8
2002	199.8	319,680	94,625	29.6
2003	372.6	596,160	250,387	42
2004	455.4	728,640	336,632	46.2
2005	328.8	526,080	264,618	50.3
2006	279.0	446,400	223,200	50
2007	392.4	627,840	315,804	50.3
Total	**2502.4**	**4,003,840**	**1,810,272**	**45.2**

These low survival rates could be attributed to competition for water and nutrients faced by tree seedlings. As seedlings are established in grassland through spot hoeing and poor spot weeding is done instead of complete weeding as in the case of PELIS. These tree seedlings also did not benefit from fertilization and protection provided by farmers. Grazing

and browsing by livestock and wild animals on young plantations caused mass death of the saplings hence low survival rates. There was no protection offered by the government as in the case of PELIS where farmers offered protection for both their crops and saplings. (table 13).

4.7: Cost of Plantations Establishment and Forest Cover

The study sought to find out if PELIS contributed to reduction in the cost of plantation establishment. From the study it came out that cost of plantation establishment for both with and without PELIS was 39,527/= and 50564/= per hectare respectively across all the six forest stations under study. This shows what KFS is saving Kshs 11,037 (21.8%) in establishing one hectare of plantation by use of PELIS. Table 4.13 below illustrates the above.

Table 4.14: Costs of plantation establishment

Category	Cost/ha without P ELIS (Khs)	Cost/ha by P ELIS (Khs)	Difference	Percent
Costs	50,564.00	39,527.00	11,037.00	21.8

The findings of the study established that the government could save up to Kshs 11,037 (21.8%) per hectare by use of PELIS. This money could be channeled to other activities like pruning. Given that farmers carry out array of activities at the preliminary stages of plantation establishment, the cost of establishing one hectare of plantation is reduced. The activities include land preparation, cultivation, pitting and planting. As PELIS farmers provide labour by carrying out the activities for free as they prepare land for their crops, the government saves a lot of money that would otherwise have been used to pay casuals.

According to FD, 2005, the cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. It was also established that multinational companies like Rai Ply, Tim Sales and Comply who are major consumers of forest raw materials insignificantly participate in reforestation of areas they have clear felled hence contribute to

continuous increase in planting backlogs. These companies should substantially compliment government efforts in reforestation in terms of raising seedlings and provision of funds for labour engagement during plantations establishment. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

4.8 Livelihood Improvement and Forest Cover

4.8.1 Main source of Livelihood

The illustration in table 4.14 is on the main sources of livelihood for the CFA farmers. They largely participate in PELIS to enhance their livelihood through diversification of sources of livelihood in form of more adequate income, increased wellbeing, and improved food security among others. It was established from the study that majority of the CFA members 210(96.3%) reported their main source of livelihood was farming -PELIS. Only 2.7% and 0.9% indicated business and employment respectively as sources of livelihood.

Table 4.15: Main source of livelihood

Category	Frequency	Percent
Farming-PELIS	210	96.4
Employment	2	0.9
Business	6	2.7
Total	**218**	**100**

The study showed that PELIS significantly contributed to food security for the forest adjacent communities as shown on table 4.14. The study findings established that 210 (96.3%) of the CFA members source of livelihood was farming-PELIS. Food security has been a challenge to our society especially the vulnerable segment. It is therefore notable that PELIS provided excellent opportunity to the poor as they are able to improve their livelihood by cultivating their crops in the forest alongside trees. By doing so they are able to secure

food for subsistence consumption and are able to sale the surplus for income so as to get other necessities of life like, clothes, shelter, food, education etc. The farmers too are able to graze their animals in the forest hence improved animal production for meat and milk and even sale for income. They are also able to get firewood and secure employment opportunities hence improved livelihood. Fresh water catchment and soil preservation are important inputs to agriculture and food production

Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

4.8.2 Shamba Ownership in the Forest

As illustrated in table 4.15 below, it was observed from the study that majority of the CFA members 214(98.2%) owned a shamba in the forest as shown in table 4.15 below. The average size of shamba owned by each former was one acre.

Among them 4(1.8%) that do not own a shamba, the reasons given were that two had not yet been allocated, one has no time to manage the farm while the other has his own farm.

Table 4.16: Shamba Ownership in the Forest

Category	Frequency	Percent
Owns forest land	214	98.2
Do not own forest land	4	1.8

The findings indicate that majority 214 (98.2%) of the farmers own plots in the forest. This could show that the main source of livelihood of the farmers was farming and also the shambas back at home were inadequate for both subsistence and commercial food production. For the farmer who does not own a plot in the forest, this could imply that the

farmer does only grazing or cut and carry grass in the forest but does land cultivation at home. The one that has not been given one is probably still new in the CFA membership and shambas are exhausted hence has to wait until the shambas are available i.e. until clear fell is done. For the 214 members that owned a shamba, the median (IQR) number of acres was 1 (0.5, 2). Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small (Prince Osei *et al*.2008).

Although PELIS was established to promote forest plantation development through enhanced forest establishment and survival of plantation trees, it has also provided other significant benefits such as making available arable land for landless and contributing to food security (Paul O Odwori at el., 2013).

4.8.3 Crop Harvest per Acre

The table below shows crop production per acre by the CFA members. On average, the PELIS farmers harvest 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre as shown in table 4.16.

Table 4.17: Crop harvest per acre

Category	Bags/acre	Max	Min
Maize	22	40	1
Potatoes	54	150	1
Beans	5	60	0.5

This means the farmers were able to get food from crop diversification and can dispose of the surplus to meet other family needs. It is on the basis of these crops that the farmers derive their livelihood from and the main driving force behind going for the government land.

4.8.4 Crops Grown Alongside Trees

From the study findings, the table below shows the response of CFA farmers if they grow their agricultural crops alongside trees. Majority of the members 202(92.5%) grew either crops alongside tree seedlings while only 16(7.5%) did not.

Table.4.18: Response of farmers on crops grown alongside tree

Response	Frequency	Percent
Yes	202	92.5
No	16	7.5

This means that PELIS ensured plantation establishment .However for the 16(7.5%) it could imply that their plots were in their first year of cultivation hence not ready for tree seedlings planting (table 4.17). The farmers are allowed to cultivate food crops which are planted between the trees on the same lands (Evans, 1992).

4.8.5 Types of Crops Grown.

As indicated in table 4.18 below, there are three main crops grown by CFA farmers in the scheme. Hundred and sixty nine (77.6%) grew maize, 109(50%) potatoes while 95(43.5%) grew beans. The potatoes are grown around the highland plateau of the county.

Table 4.19: Type of crops grown

Crop	Frequency	Percent
Maize	169	77.6
Potatoes	109	50.0
Beans	95	43.5

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The study showed that the stable food was maize which has the highest percentage; the second was potatoes and lastly beans. All these were grown for subsistence use and any surplus was sold for income to enable the families acquire other necessities. Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars (R Manyaka, 2015).

4.9 Other Benefits from PELIS

A part from securing food from PELIS, the farmers also immensely gets other benefits that ultimately enhance their livelihood socially, economically and culturally. These included; fuel wood 214 (98.2), grazing 196 (89.9%), source of income 183 (83.9%) and 155 (71.1%) as shown on table 4.19.

Table 4.20: Other Benefits from PELIS

Benefit	Frequency	Percent
Employment	155	71.1
Firewood	214	98.2
Grazing	196	89.9
Source of income	183	83.9

The study observed that besides PELIS providing food security as the main benefit there were other benefits that came along with it to the PELIS farmers. These included; source of fuel wood for majority of the CFA members 214(98.2%). The second most important other benefit it provided was grounds for livestock grazing 196(89.9%) many members of the adjacent communities were also able to get income 183(83.9%) from the sale of the PELIS crops besides provision of employment opportunities too 155(71.1%). All these other benefits were geared towards enhancing the forest adjacent communities' livelihood (table 4.19).

4.10 Perception of PELIS as Plantation Establishment Strategy by Forest Managers.

The table below shows the perception of PELIS by forest managers. All the six forest station managers applauded PELIS as the most appropriate method of plantation establishment 6 (100%). This was due to reasons outlined on table 4.20.

Table 4.21: Take on PELIS by Forest Managers

Comparison	Frequency	Percent
It enhances water absorption and retention for plant use	6	100
It reduces weeds, therefore less competition for nutrients hence increased plantation survival rate	6	100
It keeps away animals which may browse seedlings unlike grassland which is prone to animals and percolation of water is less	6	100
It reduces establishment costs and damage by pests and rodents	6	100
It significantly contributes to backlog reduction hence increased forest cover	6	100
It contributes to food security for the forest adjacent communities	6	100

Two most common methods of plantation establishment are grassland and PELIS. The former, involved establishment of plantations on grassland, without total cultivation but hoeing of planting spots, while the latter involves total cultivation of the area plantation is to be established. From the study all the forest station managers 6(100%) observed that the strategy was positive in that it enhanced plantation hygiene hence less competition for water and nutrients by trees. PELIS strategy also ensured that animals which may browse on young seedlings are kept away. It also helped to reduce the plantation establishment costs as the cost of land preparation and planting are borne by the farmers. Damages caused by pests and diseases were reduced, plantation hygiene ensured trees were not attacked by the pests and diseases. As farmers tended their crops and did fertilization, thus trees also benefited from fertilizers hence faster growth (table 4.20).

4.11 Challenges Encountered by Forest Managers during the PELIS Implementation.

Table 4.21 below depicts the challenges encountered by forest station managers during the implementation of PELIS. The study established the following as the most common challenges; interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba

6(100%). There was also late shamba preparation by farmers 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers 4(66.7%), uprooting of saplings 3(50%), need for close supervision 6(100%) during planting and after and lack of transportation means 3(50%).

Table 4.22: Challenges encountered by forest managers during the PELIS period

Challenges	Frequency	Percentage
Interference of seedlings rooting system during cultivation	5	83.3
Periodical straying of livestock/wild animals in the shambas	6	100
Late shamba preparation hence delayed time of planting	4	66.7
Over pruning of trees by those doing PELIS	4	66.7
Use of agrochemicals	6	100
Transportation of seedlings during planting	3	50
Uprooting of the saplings purportedly to create space for further cultivation	3	50
Supervision of farmers to avoid damage to the planted seedlings	6	100

The study found out that the most common challenges faced by the forest managers during the scheme implementation was interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba hence browsing or trampling on young tree seedlings 6(100%). There was also late shamba preparation by farmers which affected planting time 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers also affect the growth of the trees, uprooting and deliberate disturbance of the rooting system of the young seedling by the PELIS farmers 4(66.7%).This was to enable the farmers to continue cultivating their shambas for a long period. This affected the growth of young trees hence reduced the survival rate.

It was also established that PELIS require close supervision 6(100%) during planting and after to avoid damage to the planted tree seedlings by the PELIS farmers. Lack of transportation means 3(50%), for the seedlings during planting was also observed by the forest station managers as a hindrance to effective planting exercise. Abandonment of one

year established plantations by the PELIS farmers created room for trees competition with weeds for water and nutrients and grazing and browsing by both domestic and wild animals (table 4.13).

V. K . Agyemen, 2003, observed that in traditional taungya system there were many challenges that included, increased incidences of sabotage to tree seedlings by farmers, the farmers had more interest in their agricultural crops than the forest trees and there were many incidences of forest land encroachment. Farmers deliberately killed planted seedlings to extend their tenure over portion of land , since a successful plantation meant the discontinuation of cultivation on allocated plots, girdling of stems, cutting trees above and below ground, debarking and over pruning. Other challenges were; Cleared more land for plantation development than needed for the available seedlings. Failed to weed around tree seedlings , whereby retarding their growth so as to extend land use rights beyond three years. Illegally farmed other areas in forest reserve, degraded or not , which were not allocated for taungya.

Planted food crops that were not compatible with the tree crops leading to reduced tree growth, lack of supervision by forestry officers. Inadequate financing mechanisms, abuse of powers by public officials especially in farm allocation (Agyeman *et al*., 2003), over pruning of trees, inappropriate use of agrochemicals and encroachments of forest land for farming.

4.12: Challenges Encountered by Farmers during PELIS Implementation

Table 4.22 below brings out the challenges encountered by farmers during PELIS implementation. The findings of the study were; destruction of crops by wild animals 212(97.2%), livestock destruction 201(92.2%), pests and diseases 189(86.7%) and climate change 153(70.2%).

Table 4.23: Challenges Encountered by Farmers during PELIS period

Challenge	Frequency	Percent
Livestock destruction	201	92.2
Destruction of crops by wild animals like monkeys	212	97.2
Pests and diseases	189	86.7
Climate change	153	70.2

The PELIS farmers cited destruction of crops by straying livestock 201(92.2%), wild animals 212(97.2%) graze and browse on crops, infection and attack by pests and diseases on crops 189(86.7%)i.e. maize lethal necrosis disease and maize stalk borer were mentioned as a threat to crops production by farmers. Effects of climate change 153(70.2%) as it happened in 2014 posed a challenge to the farmers as the rainfall was inadequate and erratic. All these could result to great loses by farmers in both crops and livestock production.

Following wanton destruction of Mau forest there is significant change in rainfall patterns and temperatures .Rainfall seasons sets in late for a shorter period compared to previously with prolonged dry spells, temperatures are relatively high hence high rate of everpotranspiration and dehydration on vegetations and animals besides drying up of water bodies. This makes PELIS activities very challenging especially tree establishment (table 4.14). Farmers also indicated that they are being exploited by KFS as they don't get a share from the sale of the various forest products given that the Forest Act 2005 recognizes the CFA as key stakeholders in forest management.

4.13 Other factors influencing forest cover

On forest governance, if there are no proper rules, regulations, policies and code of conducts and ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, floods and prolonged dry spell. High poverty levels will drive the community to go into the forest to draw their livelihood. This will eventually lead to forest destruction and degradation hence forest cover loss and consequently loss of forest related benefits that would otherwise been assured if there was sustainable utilization of forest related resources.

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five reviews the whole study findings summary, conclusions and recommendations based on the study objectives. The study title was the influence of PELIS on forest cover- a case of Uasin Gishu County, Kenya. The study objectives were: to establish the influence of plantation establishment on forest cover, to evaluate the influence of plantations survival rate on forest cover, to determine the influence of cost of plantations establishment on forest cover and finally to assess the influence of livelihood improvement on forest cover.

5.2 Summary of the Study Findings

The study findings were summarized as below:

5.3. Influence of Plantation Establishment on Forest Cover

On the influence of plantation establishment on forest cover, a total of 4130.4 hectares was established with PELIS from 2008-2014. This represented 12.8% forest cover increase of the total planting backlog of 4438 hectares as at 2008 while that without PELIS was 8.4% increase. The study findings showed there was steady increase in plantation established using PELIS while that one without was relatively low. As the farmers were given plots to grow their crops, they too were expected to provide labour for land preparation, pitting, planting and protection of the planted trees.

5.4 Influence of Plantations Survival Rates on Forest Cover

In respect to plantations survival rate on forest cover, the average survival rate of plantations established with PELIS according to the study was (75.1%). The mean survival rate of plantations established without PELIS was 45.2%. The findings showed that as the farmers tended to their crops in form of weeding, fertilization and protection, trees too benefited from the same. Competition for water and nutrients was minimized through complete weeding.

5.5 Influence of Cost of Plantations Establishment on forest Cover

On the influence of plantation establishment costs on forest cover, the study established that plantation establishment with PELIS costs Kshs 39,527 and without PELIS Kshs 50,564. This translates to Kshs 11037 (27.9%) saving for the government. Land preparation, cultivation, planting, weeding and protection are very expensive exercises. And

all these are subsidized by PELIS farmers. Hence the savings can be redirected to other essential activities like plantations pruning.

5.6 Influence of Livelihood Improvement on Forest Cover

With regard to influence of livelihood improvement on forest cover, the study findings showed that the majority of the CFA members 210(96.3%) indicated that their main source of livelihood was farming-PELIS, only 6(2.7%) and 2(0.9%) indicated business and employment respectively. On average the farmers harvested 22 bags, 54 bags and 5 bags of maize, potatoes and beans per acre respectively. The findings also indicated that 169(77.6%) of the PELIS farmers grew maize, 109 (50%) potatoes while 95 (43.5%) grew beans. Many families were able to earn a living from PELIS especially food, fuel wood, employment and grazing

5.7 Conclusions of the Study

Total cultivation for plantation establishment is expensive but gives the largest established plantations area, the highest survival and growth rates. In the absence or inadequate funding or new technologies PELIS remain a viable option for plantations establishment. PELIS benefits both KFS and farmers, though mechanisms to ensure more benefits to farmers should be explored. PELIS plays a very vital role in forestry management as it is a component of participatory forest management which brings on board other key stakeholders like the forest adjacent community in sustainable management of forest resources. There was a significant increase of 12.8% forest cover of the plantations established through PELIS which was 4130.4 hectares from 4438 hectares as at 2008, hence increased forest cover. A well managed PELIS that observes the laid down guidelines can go a long way in contributing towards attainment of a 10% forest cover as a country by the year 2030 as envisaged in vision 2030 and the constitution.

The study established that the mean survival rates for plantations established with PELIS were higher compared to plantations established without PELIS i.e. at 75.1% and 45.2% respectively. This could have been due to reduced competition for water and nutrients as the PELIS farmers weeds both the young trees and their crops besides fertilization that trees benefit too from. As the farmers protect their crops from straying livestock and wild animals trees too benefits.

The cost of plantation establishment with PELIS (Khs 39,527) was reduced by

Kshs.11037 as compared to plantation established without PELIS (Khs 50,564).This reduction translates to 27.9% savings for the government. This could have been possible due to array of activities farmers carry out for free like clearing, cultivation, pitting, planting, weeding and finally protection. However, the government subsidizes the labour costs.

The study also revealed that 210(96.3%) reported that farming -PELIS is their main source of livelihood. On average the PELIS farmers harvested 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre, With 169 (77.6%) growing maize, 109(50.0%) potatoes while 95 (43.5%) grew beans. It can also be deduced that PELIS targeted the poor in the society and the majority grew maize as it is a stable food crop in Kenya.

5.8 Recommendations

The researcher recommends that:

1. Forest adjacent communities should be given incentives or other sources of income like establishment of nature based enterprises e.g apiculture, ecotourism, acquaforestry e.t.c in forest reserves so that they can devote portion of their land for tree planting hence attainment of 10 percent forest cover as internationally recommended.
2. There should be very close supervision of all PELIS activities carried out by the farmers to ensure minimal damage to the established plantations. PELIS guidelines should be adhered to and implemented to the latter (Appendix vii). The Forest Act no. 7 of 2005 provisions on governance should too be enforced. This would enhance plantations survival rates.
3. Multinational companies like Rai Ply, Tim Sales, and Comply among others should be made to supplement government efforts in terms of contributing some funds for hiring labour for plantation establishment programme as they are the major consumers of forest raw materials. This can go a long way in lowering the cost of plantations establishment.

4. There is need for the government (KFS) to fast track the Forest Management and Conservation Bill of 2014 that has a clause on cost-benefit sharing between KFS and the CFAs as the latter feel they are short changed on forest products benefits especially the share from the sale of timber that eventually would enhance their livelihood.

5.9 Suggestions for further Research

The researcher suggests the following areas for further studies:

1. The influence of PELIS on the plantation rotation age.
2. Cost benefits sharing among key stakeholders.
3. Study on increasing spacing in plantation establishment.

5.10 Contribution to the Body of Knowledge

It was observed from the literature reviewed that there was insignificant relation to the influence of PELIS notably; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement to forest cover in Kenya and globally. The literature reviewed failed to show empirical evidence on how PELIS influences forest cover. It is therefore vital to note that this study has brought out the contribution of the scheme towards attainment of the recommended international thresh hold of 10% forest cover of a country's total land area.

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APPENDICES

APPENDIX 1: TRANSMITAL LETTER FOR CFA MEMBERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu County. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly fill in the questionnaire and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX II: QUESTIONNAIRE FOR CFA MEMBERS

SECTION A: Demographic information (tick where applicable)

1. What is your gender? (a) Male (b) Female

2. How old are you? (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45 (e) 46-50 (f) Over 50 years

SECTION B: Livelihood Improvement and Forest Cover

1. What is the main source of your livelihood?

   (a) Farming- PELIS (b) Employment (c) Business

2. Do you own a shamba in the government forest?

   (a) Yes (b) No

   If no, why?...

3. If yes, How many acres?..

4. What do you grow? (a) Maize (b) Potatoes (c) Beans

5. How much yield do you harvest per acre?

   (a) Maize……….. (b) Potatoes……….. (c) Beans…...

6. Do you grow your crops alongside tree seedlings? (a) Yes (b) No

7. What other benefits do you get from PELIS?...

8. What major challenges do you encounter during PELIS period?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
………………

APPENDIX III: TRANSMITAL LETTER FOR FOREST MANAGERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu county. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly respond to the interview schedule and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX IV: INTERVIEW SCHEDULE FOR FOREST STATION MANAGERS

SECTION A Demographic Information (tick where applicable)

1. How old are you?

   (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45

   (e) 46-50 (f) Over 50 years

2. What is your highest education level?

   (a) Diploma (b) Undergraduate (c) Postgraduate

3. What is your work experience at this station?......................................

SECTION B: Livelihood Improvement and forest cover

1. Do you have a CFA? (a) Yes (b) No
2. How do they participate in PELIS?..

SECTION C: Plantation establishment and forest cover

1What is the total forest area of your station? ……………………………………….

3. What was your planting backlog as at 2008?...
4. What was your planting backlog as at 2014?..
5. How many hectares were established each year with PELIS between 2008-2014 ?.........
6. How many hectares were established each year without PELIS between 2001-2007?.....

SECTION D: Plantations survival rate and forest cover

1.What were the survival rates of the plantations established with PELIS between 2008 and 2014?

(i) 2008……. (ii) 2009……. (iii) 2010…… (iv)2011…..

(v) 2012….. (vi) 2013………….. (vii) 2014…………..

2. What were the survival rates of plantations established without PELIS between 2002-2007?

   (i) 2002…… (ii) 2003… (iii)2004…… (iv)2005…

   (v) 2006…… (vi) 2007……..

SECTION E: Cost of plantation establishment and forest cover

1 What is the cost of establishing one hectare with PELIS?..

2 What is the cost of establishing one hectare without PELIS?......................................

SECTION F: PELIS Perception and Challenges

1. What is your take on PELIS and Grassland as main methods of increasing forest cover?………………………………………………………………………………

………………………………………………………………………………………………

2. What are the major challenges you face while implementing PELIS……………………

APPENDIX V: WORK PLAN

ACTIVITY	DURATION
Topic selection	March, 2015
Proposal development	March, 2015
1st correction of research project proposal	March, 2015
1st defense of research project proposal	April, 2015
Research project proposal correction	April, 2015
Pilot-testing of research instruments	April, 2015
Data collection	May, 2015
Data analysis	May, 2015
Preparation of 1st draft of research project report	June, 2015
2nd correction of the project report	June, 2015
Final defense of the research project report	July, 2015
Final correction of research project report	July, 2015
Final submission of the research project report	July, 2015

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APPPENDIX VI: RESEARCH BUDGET

ITEM	COST (KIHS)
Typing and printing	
• Proposal	10,500
• Project	18,000
Transport	10,000
Data analysis services	5,000
Internet/library services	8,000
Miscellaneous	6000
Grand total	**57,500/=**

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APPENDIX VII: RULES AND REGULATIONS FOR IMPLEMENTING PELIS

Section 47(2) h of the Forests Act 2005 stipulates that ‘’a community forest association (CFA) authorized by the director to participate in the management and conservation of a forest or part of such a forest shall have a right to carry out plantation establishment through non-resident cultivation ‘’ among other activities.

The objective of these rules and regulations is to regulate the implementation of the PELIS scheme in forest reserves.

1. Compliance with the Forest Act.

(a). The permit holder must comply with the provisions of the forests Act 2005 and any rules made there under .Should be permit holder or his/her agents or employees commit any breach of the Forest Act or of any rules made there under, he/she will have committed an offence and will render the permit liable to cancellation or any other penalty imposed by the director in accordance with the forest act 2005.

2. Eligibility for cultivation

(a).All cultivators must be residents of areas adjacent to the forest stations and be members of a registered community forest association.

3. Demarcration of plots

a) Forest zonation and mapping will be done to identify the forest areas suitable for cultivation.
b) The individual plots will be demarcated by the area divisional forest officers, be numbered and put on a sketch map.
c) The sketch maps shall be displayed on the station notice boards.
d) A site –specific management plans will be complied for each forest station implementing PELIS.

4. Allocation method

a) Implementation will be through CFA management committees, consisting of representatives of cultivators.
b) A ballot system will be used in all cases during allocation of plots.
c) All participating CFAs must sign an agreement form before cultivation commences
d) All selected cultivators must obtain a permit before cultivation commences.

5. Crops to be crown

a). Only maize, beans (non-climbers), potatoes, carrots, peas, onions Dania, Chilles, amaranths and cabbages shall be planted in PELIS scheme. The service may review the crops to be grown from time to time.

6. Cultivator's obligations

a) The CFA leadership will ensure that none of its members or ants will take any action that will be harmful to the survival of the plated trees.
b) The cultivator shall ensure that he/she and or/his agents will not take any action that will be harmful to the survival of the planted stock. If the survival is low they will participate in either beating up or replanting, whichever is appropriate.
c) Any form of interference with the normal growth of seedlings and trees is prohibited.
d) The CFA, its agents or employees shall give assistance whenever called upon by the service in controlling illegal activities and in preventing or fighting forest fires.
e) No permit holder will be allowed to lease out or sell the allocated plot. Any attempt to lease or sell a plot will lead to the plot being reposed and plot will revert back to the service.

7. Commencement of tree planting and cultivation period

a) Planting of tree seedlings shall be done after one crop season (one year)
b) Cultivation period shall not exceed three years after tree planting. After this period, a permit holder shall vacate his/her plot.
c) Kenya Forest Service will not be obliged to allocate another plot at the expiry of 3 years period.

8. Areas restricted for cultivation

a) Cultivation shall not be allowed within the water catchment areas and slopes exceeding 30%
b) Cultivation shall not be allowed within a minimum of 30 meters on either side of river valleys and wetlands.
c) Cultivation shall not be allowed in firebreaks, roads reserves and natural forest and under plantations over 3 year old.

d) Under no circumstances shall cultivation be re-opened in plantations after expiry of the authorized 3-year period.

9. Tools and equipment for land preparation and use of fire

   Hand tools will be sued for land preparation but animals drawn equipment may be used for the initial opening up. Use of tractors and combine harvesters is prohibited.

   Use of fire in land preparation is prohibited .If the use of fire is absolutely necessary; the divisional forest officer shall give written authority, after inspection of the area.

10. Payment of shamba rent

    All cultivators will pay prevailing annual rental fees for the allocated plot before cultivation commences for that particular year.

11. Erection of temporary structures

    No residential structures will be allowed in PELIS scheme areas except in areas with high incidences of game damage. Construction of such structures shall be erected under a written permit from the director who may also issue guidelines on the number of such structures in a forest area.

12. Penalty of abuse of the system

    Any cultivator who flouts these conditions will:

    a) Lose the right to cultivate in the forest
    b) Be liable to prosecution as specified in the forest act
    c) Be liable to both (a) and (b) above
    d) Loose any crop that may be on the plot to the service

13. Areas to be opened up for cultivation

    a) The opening up of any new areas should be commensurate with the planting programme.
    b) Any opening shall only be authorized by the divisional forest officer after inspection of the area and consent from the director of KFS
    c) Plot demarcation shall be done under the supervision of the divisional forest officer.
    d) The plot sizes shall a maximum of one acre and a minimum of ½ acre.

14. Documents to be maintained

    Each station shall maintain a shamba register indicating locality, sub-

compartment number, name of cultivator, national identity card number, and receipt number, date of payment and size of plot.

A sketch map of the area under cultivation shall always be maintained, updated and be prominently displayed in the forester's office.

A register of all temporary structures shall be maintained where applicable.

15. The divisional forest officer will be held responsible for any abuse of the system.

NB: The field stations will receive all the 15 conditions but the farmer should be given the first 14 conditions translated into Kiswahili .The 14 conditions will be prominently displayed in the station notice boards.

APPENDIX VIII: DRAFT PELIS CULTIVATION PERMIT

The PELIS cultivation permit is granted to Mr./Mrs./Miss/Ms……………………….
ID NO………………………… Member of …………………………………………………. Community Forest Association of P.O BOX …………………………………………to cultivate plot number……………………………….measuring ………………..hectares for purposes of identification marked in red and numbered accordingly on the sketch plan on this permit in Sub-Compartment Number………………………………….in ……………………….Forest Station for a period of one(1)year, subject to the following terms and conditions.

1. This permit only allows the permit holder to use plot .This permit does not make the permit –holder owner of the plot. The permit -holder has no right to sell, rent, or act as owner of plot in any way.

2. The permit-holder shall plant only annual crops on the plot. The service has a list of approved crops. The permit –holder shall choose his crops from this list and plant only annual crops.
3. The permit-holder shall help the service upon request in
    a. Beating up or replanting, whichever may be appropriate, in cases of low survival of tree seedlings.
    b. Controlling illegal forest activities
    c. Preventing or fighting forest fires and
    d. Any other activity for the benefit of the forest.
4. The permit –holder shall use hand tools to work the plot but animal drawn equipment may be used for the initial opening only.
5. The permit-holder shall not build any structure on the plot, except with written permission of the service.
6. Breaking the terms of this permit is an offence and if that happens, the service may withdraw this permit. A permit-holder who breaks the terms of this permit may be liable to other disciplinary measures.
7. The permit –holder accepts the risk of injury, harm or death from trees, logs, wild animals, game, rivers and streams, and other hazards on the plot and neighboring forest. Whether the injury happens to property, the permit-holder, or another person, the service is not responsible.

8. This permit does not give the permit holder exclusive possession of the plot or any part thereof and does not create not is it intended to create a lease or tenancy in any way whatsoever.

Signed by the Permit holder……………………Counter signed by CFA official……………

Date ………………………   Date……………………………

Name of issuing Officer…………………………………………………………………………

Official Stamp …………………………………………….Date………………………

APPENDIX IX: RESEARCH AUTHORIZATION LETTER

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/0581/6469**

Date:
9th November, 2015

Tobias Otieno Achungo
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of plantation establishment and livelihood improvement scheme on forest cover a case study of Uasin Gishu County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Uasin Gishu County** for a period ending **17th July, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Uasin Gishu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Uasin Gishu County.

The County Director of Education
Uasin Gishu County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX X: RESEARCH CLEARANCE PERMIT

THIS IS TO CERTIFY THAT:
MR. TOBIAS OTIENO ACHUNGO
of UNIVERSITY OF NAIROBI, 41-30100
eldoret,has been permitted to conduct
research in *Uasin-Gishu* *County*

on the topic: *INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER A CASE STUDY OF UASIN GISHU COUNTY KENYA*

for the period ending:
17th July,2016

Permit No : NACOSTI/P/15/0581/6469
Date Of Issue : 9th November,2015
Fee Recieved :Ksh 1,000

……………………………
Applicant's Signature

……………………………
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 7122

CONDITIONS: see back page

INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER: A CASE OF UASIN GISHU COUNTY, KENYA

BY

TOBIAS OTIENO ACHUNGO

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT

UNIVERSITY OF NAIROBI

2015

DECLARATION

This research project report is my original work and has not been presented for a degree in any other university.

Sign________________ Date ________________

TOBIAS OTIENO ACHUNGO

L50/71180/2014

This research project report has been submitted for affirmation with my approval as university supervisor.

Sign____________________ Date________________

KORINGÚRA JULIUS

Lecturer Department of Extra Mural Studies

School of Continuing and Distance Education

University of Nairobi

DEDICATION

This research project report is dedicated to my family for their unwavering support, prayers a nd patience during the entire preparation period.

ACKNOWLEDGEMENT

I wish to register my sincere appreciation to my supervisor Koring'ura Julius for finding time out of his busy schedule to guide me through the preparation of this research project report. It is with humility that I register my gratitude to my lecturers; Dr Paul Odundo, Dr Anne Assey, Mr. Sakaja, Mr.Patrick Cheben, Mr. Ochieng Owuor and Mr Peter Lukhuyani, for taking me through the various courses that were relevant to this study. I would also wish to thank my employer, Kenya Forest Service for granting me an opportunity through a course approval to sharpen my skills, knowledge and experience to enhance my performance. I also recognize the immense support from fellow students during the course and project write up. I salute the University of Nairobi for providing an enabling environment to help me reach this far. My heartfelt gratitude also goes to my family once more for their patience, support and prayers during the study. And finally I thank Mss Gladys for taking her time to do typesetting and formatting this research project report.

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LIST OF ABBREVIATIONS

AFCN	African Forest Conference Network
CFA	Community Forest Association
FAO	Food and Agriculture Organization
FC	Forestry Commission
FD	Forest Department
FRA	Forest Resource Assessment
FR	Forest Reserve.
FRIN	Forestry Research Institute of Nigeria
FSD	Forest Services Division
IGA	Income Generating Activities.
KFS	Kenya Forest Service
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MFW	Ministry of Forestry and Wildlife
MMMB	Miti Mingi Maisha Bora
MTS	Modified Taungya System
NACFA	National Alliance for Community Forest Association
NEMA	National Environment and Management Authority
NP	National Park.
PELIS	Plantation Establishment and Livelihood Improvement Scheme
PFM	Participatory Forest management
REDD+	Reduction in Emissions from Deforestation and Degradation
REMA	Rwanda Environmental and Management Authority
UNEP	United Nations Environmental Programme
WB	World Bank

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ABSTRACT

There has been increasing rate of forest destruction and consequently decline in forest resources in Kenya due to the high rate of increase in human population, thus exerting pressure on natural resources. The decline has been attributed to factors such as deforestation, commercial agriculture, urbanization, pastoralism, charcoal production, forest cultivation, illegal logging, forest fires and replacement of indigenous forests with exotic plantations. Decline in forest resource has been further exacerbated by increasing poverty levels and the community perspective of forest as public good in addition to changing global forest trends. It is on this back drop in forest cover levels that the government of Kenya through Kenya Forest Service modified "shamba system" to PELIS which for a long time has been used by the government of Kenya to raise forest plantations where the forest adjustment communities benefits from cultivation of crops in the forest and KFS benefits from forest plantation establishment at low costs. The key objectives were; to establish the influence of plantation establishment on forest cover, to determine the influence of plantation survival rate on forest cover, to investigate the influence of cost of plantation establishment on forest cover and to assess the influence of livelihood improvement on forest cover. Therefore this study aimed at establishing the influence of PELIS as a strategy to increase forest cover. The study was informed by the theories of Environmental Kuznets Curve and forest transition, which affirms that a U shaped relationship exists between environmental quality and economic development and also contends that forest cover, is an indicator of environmental quality and income levels. Survey research design was used. The study targeted a population of 6521 including 6 forest station managers and 6515 CFA members. Stratified, purposive and simple random sampling methods were used to select forest stations and CFA members for the study. Structured questionnaires, interview schedules and personal observations were used to collect primary data besides use of secondary data from the offices. Descriptive statistics such as means, tables, percentages and frequencies were used. The findings of the study provided an insight on the contribution of PELIS in increasing forest cover. The study established that PELIS contributed to 12.8 % increase of forest cover. The results clearly showed that the survival rates were higher in plantations established with PELIS than those established without PELIS by an average of 75.1% and 45.2% respectively. On the cost of plantation establishment, it was established that the cost was Khs 39,527 with PELIS while without PELIS was Kshs 50,564 representing 27.9% savings. The study also confirmed that there was livelihood improvement as PELIS farmers harvested an average of 22 bags, 54 bags and 5 bags of maize, potatoes and beans respectively. The study also established that 96.3% of CFA members dependent on farming-PELIS as a source of livelihood. It was recommended that there is need to give forest adjacent communities alternative sources of livelihood as incentives so that they could allocate a portion of their land for tree growing, there should also be closer supervision of all PELIS activities to reduce damage to young plantations. Multinational companies should supplement government efforts through provision of funds for reforestation and government should fast track forest management and conservation bill that provides for benefit sharing.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

The world's forest, cover some 3500 million hectares, of which 57% of these are located in developing countries mostly in the tropics, worldwide about 1.6 billion people rely heavily on forest resources for their livelihood and estimated 400 million are directly depended on forest resources. Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. It is estimated that the rate of global forest loss has hit 13 million hectares per annum in the last decade (2000-2010) (FAO, 2010). The world looses 7.3 million hectares of forests a year, about four times the size of all gazetted forests in Kenya. Due to extensive reforestation, this new forest shrinkage has slowed slightly from the 8.9 million hectares lost in the 1990s. Despite the decrease, deforestation has not declined significantly since 2000 (KFS, 2014). Globally tropical forests are being reduced at the rate of about 7.5million hectares of closed forest and 3.8million hectares of open forest annually (Lenely, 1982). The global net rate of change in forest cover for normal tropics is estimated to be 23% (Arched *et al*, 2002) signifying a high reduction rate of forest covers.

Closer home, Africa has lost 64 million hectares of forest between 1995 and 2005, the greates decline on any continent during the same period. Fuel wood gathering drives much of the forest depletion. Timber exports also play a role, with 80% of the Congo basin’s timber production being exported, mainly to China and European Union. Much of the world’s wood is harvested illegally. Illegal logging accounts for more than half of timber production in Russia, Brazil and Cameroon. In addition to devastating forest ecosystems, illegal logging robs forest dwellers of their livelihoods, fuels social turmoil, and deprives timber producing countries of up to ksh. 1.14 Trillion of revenue annually (KFS, 2014).

In the case of Africa, even though most tropical African countries had considerable forest cover at the beginning of the 20th century that ensured environmental stability, the need to increase food production, high demand for wood products and rapid increase in infrastructural development to satisfy growing population has resulted in rapid increase in deforestation and forest degradation (Forestry Commission, 2011). KFS, 2014 observed that forest cover loss leads to; increased occurrence of floods, reduced recharge of ground water, decreased water volume in rivers during dry seasons, sometimes rivers dry up, increased drought periods from an average 2 year cycle to 4 year cycle, increased sediment loads in

rivers, lakes and oceans, changing rainfall patterns, soil desiccation, inadequate timber and fuel wood, loss of bio diversity and intrinsic value of forests amongst others. All these are as a result of climate change.

FAO (2010) observes that, over the last century for example, forest cover in the African region has been under intense pressure from human activities in the name of livelihood sustainability and development. This perhaps explains why Africa now has the second highest rate of deforestation worldwide with 3.4 million hectares of forest loss per annum. Thus the need to seek remedial measures through community, national and global initiatives such as Reducing Emissions through Deforestation and forest Degradation (REDD+) has been well received by many policy makers and governments towards environmental sustainability and green development, as enshrined in the goal seven of the Millennium Development Goals (Karsenty *et al*., 2012). However, the expense of forest areas is declining across the globe partly as a result of logging activities and also due to conversion of habitat to crop land, agricultural expansion accounts for up to 43% of tropical forest losses (MEA, 2005).

This has led to the recognition of the need to include the communities living close to forests through CFAs in management of forest resources to reduce this rate of forest loss. Only 32.5million hectares of African forest and woodlands or 5% of the total forest area are formally protected. The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in western, central and eastern Africa where there in considerable forest cover (UNEP, 2005).

Africa and South America distinguish themselves by showing distinct decline in forest cover. For Africa the direction for the past twenty years is clear even though the rate of deforestation seem to have declined over the last few years. However, forest cover alone does not tell us what kind of forests we have , what benefits they might provide, how well they are managed or if they are degenerated (FAO, 2010). In the Lake Victoria basin problems among other things such as soil erosion and declining soil fertility have been attributed to loss of forest cover (World Agroforestry Centre, 2006). The land was formerly rich in natural forests but this resource has been severely over exploited. Deforestation combined with unsustainable agricultural methods has resulted in widespread, increasingly conspicuous land degradation (Maitima *et al*., 2010). As a result of the above, there is need to stop further deforestation through conventional strategy to save biodiversity for the survival of human

kind.

According to MMA (2008), Africa has high per capita forest cover of 0.8 hectares per person compared to 0.6 hectares globally. On average forests account for 6% of GDP in Africa which is the highest in the world. In Uganda for example forests and woodlands are now recognized as an important component of the nations stock of economic assets and contribute in excess of US $54.6 million to the economy through forestry, tourism, agriculture and energy. The state of Rwanda's forests and woodlands and their importance to the national economy is also well documented. Forests are designated as protected areas which host game parks and forest resources and make contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. They also make an indirect contribution to sustainable agriculture and are sources of medicine, fodder, honey, essential oils as well as handcrafts and construction materials. However, they are also threatened by mining, fires and poaching (REMA, 2009).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. FAO, 2013 noted that there has been a straight line decrease in forest cover in Kenya between 1990 and 2012 ie 1990 37,080km^2, 2000 35,820km^2 and 2012 34,450 km^2. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

Muthike (2004) notes that forests plays a vital role in water catchment protection, climate change mitigation, agricultural production, hydroelectric power generation, habitat for wildlife, ecotourism, food, employment, income, research and education among others. In addition over 1 million households, living within a radius of five kilometers from the forest reserves depends on the forests for cultivation, grazing, fishing, food, fuel wood, honey, herbal medicine, construction materials, water and other benefits (KFS, 2012). Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

Despite all these importance, the forests are under tremendous pressure from growing population and therefore innovative strategies are required to support their sustainable management (KFS, 2012). Forest cover in Kenya has been decreasing over the years and the main drivers have been poor legislative frame work and governance, politics, encroachment, illegal cultivation, illegal logging, charcoal burning, excision, poverty, population pressure, industrialization and poor understanding of the benefits of forests by the local communities.

World Bank (2007) observes that sawn timber remains highly valued and in short supply in Kenya for a number of reasons. One is that the land available for forest is diminishing in medium to high potential again ecological zones. Forests in such places face direct competition from land for agriculture, infrastructure and urban development estimated at 5,000 excerbarated by an increasing population on limited available land is dramatically reducing forest acreage. The enactment of the Forest Act 2005 as admittedly helped to revitalize the section by giving local communities a stake in the management of state and county forests.

As in many countries, Kenya official status do not accurately reflect the extend of forest resources as a contributing factor to the economy. These gaps fuel the perception that forests meet substitutes needs only and is therefore not important. Data for the period 1989-2005 indicate little change in forest cover yet known existence suggest the figure for gazetted forests should be lower. Conversely extensive tree planting which took place under the afforestation and extension scheme on private land and state forests and in some forests managed by local authorities should show higher forest cover in these areas. It is therefore recommended that a participatory approach to formulating and implementing forest policies is adopted in order to ensure local communities support (KFS, 2014).

1.2 The Concept of Taungya System

1.2.1 Taungya System in Thailand

In Thailand, a country that neighbours Burma, the destruction of forest through shifting cultivation was a serious problem. More than 10,000 hectares of forest lands were denuded annually by hill tribes and other farmers . Forest village scheme was introduced by the government and Forestry Organization as an attempt to stop further spread of shifting cultivation and deforestation. The forest village system offered hill tribesmen and others who practiced slash and burn agriculture considerable inducements to settle down. One of principle aims of the scheme was to keep a steady labour force on

hand for long term needs of forestry, while at same time providing rural families with income and other benefits from the kind of farming they choose to practice (S A O Chamshama *et al.,*1992).

The underlying principle of the scheme was to link reforestation with social welfare of the people involved. A systematic programme of public information and the involvement of community leaders were necessary to gain public acceptance of forest villagers before they could be started in the FVS, the families were allowed to grow crops during the first three years of establishment. The families were also provided with free agricultural advice, primary education and medical services. Families who agreed to give up shifting cultivation for settled land use were given tenure of a plot of land to construct a house and develop a home garden, where crops could be grown and few animals reared. In return the farmers were required to help establish and maintain forest plantations. (S A O Chamshama *et al*.,1992).

Although the scheme rain well below targets, opportunities had been provided for people to settle, with long term employment prospects and affording a higher standards of living than previously. The families had abandoned shifting cultivation thus reducing pressure on native forests. Also, through forest villages biodiversity had been improved. Not with standing numerous weaknesses and constraints of the scheme were identified, which included setting up of villages with promised facilities required significant expenditure, there was scarcity of capable managers to oversee the village functions, where forest was still plentiful, ensuring adherence to forest village policy was difficult, and so illegal shifting cultivation continued ; some sites were on steep slopes with poor soil, thus cultivating crops was hard and yields were low, cash flow problems arose as payment as payment of bonus were not made until the end of the first year of participation. Furthermore, financial incentives were too low for some ,resulting in their leaving to seek work elsewhere (S A O Chamshama *et al*.,1992).

1.2.2 Taungya System in Uganda

In Uganda, taungya has been practiced for many years. Uganda admits taungya to be a good practice of carried out properly like it was done in Burma. By planting trees with food crops weed invasion was prevented and soil cover was retained and through taungya there was a maximum use of land as both crops and trees were grown. Also employment was provided over a large scale.(tree growers and crop growers are all

employed) and there was cheaper forest establishment and protection and whose legummous crops were grown, the nitrogen benefited the trees, yet and certainly most important, taungya system promoted food security. However, over the past 30 years or so, the results of taungya have been disastrous in terms of establishment of tree plantations. Farmers faced with possibility of becoming landless, once the trees are fully established often damaged or killed the trees (S A O Chamshama *et al.*,1992).

In some parts of Uganda , farmers severely pruned the trees branches to prevent them from shading their crops, whereby extending the period they can use the land for their crops. In some instances, farmers physically uprooted the trees (or partially uprooted to severe some of the roots) to further extend the period they can grow their crops, some instances of heaping weeds on top of saplings had also been recorded. Furthermore, the farmers planted unacceptable crops such as planting tall crops, like maize and sorghum, which soon overtopped the trees so weakening and killing them, several crops species are known to be controversial and are excluded in forest plantations in some countries, such crops include bananas and plantains. (Musa spp), Cassavas (*Manihot utilissima*) and sugar cane *Sacharum officinarum*). Sugar cane for example, is generally extended because it is a long growing crop, so it is feared to deplete the soil and because it casts a heavy shade, Also it is known that allelepathic effects exists in which sugar cane suppresses the growth of trees seedlings (S A O Chamshama *et al.*,1992).

Most Taungya problems in Uganda were reported to have been caused by luck of adequate supervision. To redress the situation and to ensure equitable access to forest resources, the government of Uganda formulated policies and laws to ensure that communities, especially vulnerable ones participated in decisions that affect their livelihoods. One such policy was that of collaborative forest management (CFM). CFM is an approach that enhances community participation and development of partnerships for Forest management. In areas where CFM is implemented that is better enforcement of forest rules (D .A. Ndomba *et al.*, 2014)

1.2.3 Taungya System in Ghana

In Ghana about 75 percent of her forest plantations were established using taungya system in the earliest version of taungya that was launched in Ghana in 1930, the farmers had no rights to benefits accruing from the planted trees. Also, the farmers had no decision making role in any aspect of forest management. A s as a result , the farmers

tended to neglect the tree crops since they would not directly benefit when it matured. The farmers also realized that if the tree canopy closed, they would be asked to stop farming to enable the establishment of the tree crop from which they would not benefit. Consequently, most farmers deliberately killed the trees so that they would not be asked to stop farming. Other evils committed by the farmers included clearing more land for plantation development than was needed for available seedlings. They failed to weed around the seedlings , there by retarding their growth so as to extend land use rights beyond three years; the farmers also illegally farmed other areas of the forest reserved whether degraded or not (S A O Chamshama *et al*.,1992).

Furthermore, the farmers planted food crops most were not compatible with the tree crops leading to reduced tree growth. Other problems included lack of supervision by the forestry department; inadequate financing mechanisms and abuse of power by public officials, especially in farm allocations. As a result, the system was suspended in 1984. Following these observation the taungya system in Ghana was revised in 2002 to make itself financing and sustainable and partly to provide employment and alleviate poverty in the rural communities. (S A O Chamshama *at el*.,1992). In the new version, the farmers became owners of forest plantation products while (FC) and forest adjacent communities were shareholders. The farmers provided labour, did pruning and maintenance and tending of forest plantings; the Forest Commission provided technical expertise, farmers training, provision of equipment and tools , stock inventory and marketing of forest products; the land owners contributed land while the forest adjacent communities provided the services of protecting the investment from fire.

The consultation process devised an equitable benefits sharing frame work based on Contribution of the participants. These levels of contribution together with stakeholder expectations led to the following benefits sharing framework; The farmers get 40% of Timber benefits; the forest communities gets 40% , the land owners get 15% while Forest adjacent communities get 5% of the benefits accruing from the Modified Taungya System (MTS). This was to ensure sustainable system and continuous flow of benefits to participating farmers after harvest of food crops at the end of third year and there should be some bulk payment at the time of harvesting logs. (O. A Ndomba *et al*., 2014)

1.2.4 Taungya System in Kenya

In Kenya, Taungya system was adopted in 1910 and was referred to as shamba

System. First introduced as a modified form of the taungya used in south East Asia; the shamba system was a method, of forest plantation established in which farmers tend tree saplings on state owned forest land in return for being permitted to intercrop food crops until canopy closure. The shamba system significantly reduced the cost of forest establishment as weeding costs were borne by the farmers. The system also provided significant benefits to farmers in the form of food.

In 1990s the shamba system was often abused and young trees were often neglected or deliberately cut to enable cultivation to continue beyond the usual three years period. These actions slowed down reforestation progress and resulted in vast areas of land under cultivation within forest reserves. Following these mishaps the system was banned by presidential decree in 1987, and in the following year all forest residents were evicted from forest areas. The shamba system was subsequently replaced by

A modified system referred to as Non- Residential Cultivation (NRC). In the NRC, farmers were Integrated into the Forest Department (FD) as resident workers. Under NRC the farmers were allocated plots , still by the name ‚shambas' but with guaranteed work for nine months per year. The produce from the shambas was considered part of workers emolument as they tended the young trees. This NRC too was banned after a few years and was being replaced with a redesigned system referred to as the Plantations Establishment and Livelihood Improvement Scheme (PELIS). The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation (O.A. Ndomba *et al.;* 2014).

1.2.5 Justification for Plantation Establishment and Livelihood Improvement Scheme (PELIS)

PELIS involves farmers planting and tending the saplings on a state owned forests in r eturn for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years). Before being allowed to cultivate in the forest they sign a PELIS cultivation permit where they commit themselves to abide by the rules and regulations that govern the scheme (Appendix vii). The scheme is meant to improve the economic gains of participating farmers while ensuring success for planted tree (AFCD, 2012).

In mid 2007, acting in conformity with the Forest Act 2005, the Kenya Forest Service (KFS) in collaboration with key sector partners particularly forest adjacent communities revis ited the pros and cons of Non –Residential Cultivation (NRC). KFS outlined a new model, re-branded as the Plantation Establishment and Livelihood Improvement (PELIS).

The overall objective of PELIS was to establish forest plantations and improve the livelihoods of communities through sustainable collaborative management of gazette forests. The PELIS initiative was to have the following other objectives.

1) To reduce the cost of plantation establishment that currently stands at Kshs.25.000 per hectare at three years using the pitting and spot weeding method as compared to about Kshs.10,000 per hectares under shamba system (by 2007).

2) To improve the rate of growth of the planted stock as would be the case under complete cultivation as compared to pitting and spot weeding method.
3) To allow the people leaving next to forest reserves improve their food security and incomes through raising of crops together with trees in forest reserves and hence change their attitudes to forest conservation.
4) To reduce and eventually eliminate replanting backlogs that currently stands at 16,000 hectares.
5) To minimize the need to seek assistance in plantation establishment from forest based industrial companies.
6) To minimize the need for KFS to hire labour for plantation establishment.
7) To achieve sustainability in harvesting and replanting of plantations. (KFS, 2007)

1.3 Statement of the Problem

Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. Forest underpin important sectors of the economy including agriculture, tourism, energy, water and manufacturing among others. Further 80% of the population depends on wood as the primary source of energy.

Kenyans population is on the rise and stood at 38.6milion in 2008 and at the 2.9% growth rate. The resulting high demand for forest and woodland products by arising population created led to conflicts and environmental degradation as forest are cleared to make way for human settlement and agriculture, industrialization, frequent drought in Narok,

for instance are attributed to the rapid growth of settlement and the increased rate of deforestation by conversion of burning and illegal logging upstream in the Mau forest.

It was on this background of the myriad products and services that forests provide to human kind and other flora and fauna. Hence it was important to check on the growing negative effects of climate change that is aggravated by the continued deforestation with the key driver being human induced activities. PELIS as strategy is capable to reverse the trend if well managed and the rules and regulations governing the scheme are observed to the latter.

1.4 Purpose of the study

The purpose of the study was to establish the influence of Plantation Establishment and Livelihood Improvement Scheme (PELIS) on forest cover.

1.4.0 Research Objectives

1.4.1 Objectives of the Study

1. To establish the influence of plantation establishment on forest cover.
2. To determine the influence of plantation survival rate on forest cover.
3. To investigate the influence of cost of plantation establishment on forest cover.
4. To assess the influence of livelihood improvement on forest cover.

1.5 Research Questions

1. How does plantation establishment influence forest cover?
2. How do plantation survival rates influence forest cover?
3. How does the cost of plantation establishment influence forest cover?
4. How does livelihood improvement influence forest cover?

1.6 Significance of the Study

The continued degradation of forests resources calls for concerted efforts by the policy makers and researchers to slow or stop the loss of forest cover. The findings of the study will help the policy makers in the industry to know the level of success or failures of PELIS and make the necessary adjustments if need be. The researcher will be able to fill the

knowledge gap in terms of the role of PELIS in increasing forest cover. The government will also be able to appreciate the role of PELIS in terms of bridging the gap on food insecurity.

KFS as a key player will be able to determine whether it is working towards achievement of 10% forest cover as envisaged in the constitution and the internationally recommended thresh hold. The study will also influence level of participation of donors in the sector by having confidence and continue funding if the forest cover level increases. Positive results will gear the country towards economic development by improving the key sectors of the economy like industries, agriculture, energy and tourism that largely depend on sustainable management of forest resources.

1.7 Basic Assumptions

The study assumed that all the six forest stations under the study are practicing PELIS and by extension have Community Forest Associations (CFAs). The planting backlogs have substantially been reduced. The researcher assumed that the respondents will cooperate and give honest response to the questions in research tools. It was also assumed that the sample size chosen was adequate to enable the researcher draw valid conclusions on the study.

1.8 Limitations of the Study

In the course of the study it was difficult to obtain the updated information on the plantation records. The CFAs also provided varied information on food production through PELIS, this was overcome through verification of secondary data with field data, interviews and personal observations. Weather, difficult terrain and vast areas of some forest estates also posed some challenges during data collection in the field this was lessened by visiting the field early in the day and putting on the right attire. Language barrier was also a challenge and was minimized through an interpreter. The study used structured questionnaires, secondary data and interview schedule as data collection tools besides personal observations.

1.9 Delimitations of the study

The study covered the six forest stations in Uasin Gishu County. As anything more than this could not be viable given the time limit and resources available especially funds. Given that NRC was modified to PELIS in 2007 and its implementation started in 2008 in selected stations in the country. The study covered plantations established 2001-2014.

1.10 Definition of Terms

Plantation Establishment and Livelihood Improvement Scheme	PELIS involves farmers planting and tending the saplings on a state owned forests in return for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years) (AFCD, 2012).
Plantation Establishment	It encompasses species selection, site clearing, staking out, pitting and planting of the tree seedlings in the field.
Forest cover	It is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production system (for example in fruit plantations and agro forestry systems) and trees in urban parks and gardens (FAO, WB, 2015) It is an area more than 1 ha in extent and having tree canopy density of 10% and above.
Livelihood	It is a means of making a living. It encompasses people's capabilities, assets (including both material and social resources), income and activities required to secure the necessities of life.
Livelihood improvement	This is when livelihood is sustainable and it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conways,1991).
Planting Backlog	These are un stocked areas that were either clear felled or opened up for PELIS but have not been planted.
Survival Rate	It is the percentage of saplings surviving after six months of establishment in their natural environment.
Sapling	A young tree, especially one not over 10cm in diameter at breast height.
Acquaforestry	It is the science of raising acquatic animals and trees.
Apiculture	It is the management and study of honey bees.
Taungya	It is a Burmas word meaning hill cultivation; it was introduced

in India in 1 890. It is a modified form of shifting cultivation in which labour is permitted to raise crop in an area but only side by side with the forest species planted by them.The practice consist of land preparation, tree planting, growing agricultural crops for 1 – 3 years until shade becomes dense and then moving on to repeat the cycle in different areas

1.11 Organization of the Study

Chapter one represents background of the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study. It also entailed delimitations of the study and definition of terms as used in the study. Chapter two covers review of related literature on plantations establishment, plantations survival rate, costs of plantations establishment and livelihood improvement on forest cover. Theoretical and conceptual frameworks and gaps in literature review were also highlighted.

Chapter three described research methodology, which included research design, target population, sample size and sampling techniques, research instruments, pilot testing and data collection procedures, data analysis and ethical considerations. Chapter four gives detailed analysis, presentation, interpretations and discussions of the study findings while chapter five reviews the whole study summary, conclusions and recommendations based on the study findings.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The chapter looks at both theoretical and empirical literature related to plantations establishment and livelihood improvement scheme (PELIS) and its influence on forest cover. The chapter also reviews the independent variables in relation to the dependent variable. It also identifies knowledge gaps that are as a result of analyzing the theoretical and empirical literature.

2.2 The Concept of Forest Cover

Deforestation in all of the Kenyans five water towers is mainly due to poor environmental governance. This consequently include loss of forests cover, increased soil erosion, drying or rivers and stream, siltation in dams and increased cost of forest related products such as timber (NEMA, 2005). Forest and woodlands are particularly vulnerable to climate change. This is because the impact of climate change and variability led to change in land cover and land use, increased incidences of pests, diseases and fire outbreaks and foment loss of livelihoods (Ogwang *et al*, 2010). Apart from offering oxygen, fuel and building materials, trees store important quantities of carbon , which if released, contribute to global warming (FRA, 2015). Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water resources which loses its quality as forests condition worsens (MEA, 2005).

Over 80% of Kenyans rely on wood biomass for their energy requirements, which exerts considerable pressure on the tree and forest resources. In addition, the wood conversion technologies for timber manufacturing and charcoal production are obsolete and wasteful leading to overharvesting of trees to meet the demand. Globally and nationally the climate is changing, and this is having a direct impact on forest resources and ecosystems and on people and their livelihoods flooding, landslides and drought. Forestry can play an important role in both mitigation and adaptation to climate change, and towards green growth. Forest plantations supply industrial wood and also play a crucial role in conserving biodiversity, providing habitat for wildlife, conserving soils and regulating soils and regulating water supplies and sequestering carbon dioxide, they also reduce pressure on the indigenous forests (Forest policy, 2015).

Of late weather patterns have changed in the county especially rainy seasons comes late, the rains are erratic, prolonged and intense droughts coupled with drying up of rivers and springs. The price of forest products have also been ballooning due to acute scarcity. It is therefore on this background that the study explored the influence of PELIS in increasing forest cover in state forest areas to mitigate on the above mentioned challenges. Demand for sawn timber, furniture, timber packaging and less end use is increasing as building construction is expanding and standard of building is improving. Consumption in 2010 is estimated at 855,000m3 consisting of Kenya production of 760,000m3 and imports of 95,000m3, (MMMB, 2013).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

MFW,2013 observed that forests in Kenya including plantations are important in conservation of biological diversity, regulation of water supplies; carbon dioxide sequestering and are major habitats for wildlife which promotes tourism. Forest conserves water catchment areas. They also provide water to support irrigation schemes that are important for agricultural sector development (ICFW, 2013). M Nichlon, 2000 observed the role of native forest as to restore ecosystem services like water quality, water provision, air quality, soil quality, soil conservation among others. Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

2.3 Policy and Legislation to Improve Forest Cover

Kenya’s forest cover is disappearing at an alarming rate. According to sessional paper No.1 of 2007 on forest policy; our forest cover was less than 2% of the total land area as opposed to internationally recommended standards of at least 10%. Lack of adequate

budgetary allocation by the treasury and staff shortage made it necessary to involve the community in a forestation exercise. The PELIS strategy was expected to deliver benefits of increasing the forest cover by involving the forest adjacent communities who were directly affected by both positive and negative activities in the forest.

The forestry sector has been characterized by ineffective regulatory mechanisms and inadequate law enforcement. The Forest Act no. 7 of 2005 that became effective in 2007 was a milestone in forest governance and brought about Community Forest Association participation in plantation establishment through non resident cultivation and protection of the forest resource (Forest Act no. 7 of 2005). Further the promulgation of the of the constitution brought new requirements for natural resource management such as public participation, equity in benefit sharing, devolution and the need to achieve 10% forest cover among others (Constitution of Kenya 2010; Vision 2030, 2008). These challenges are compounded by dwindling public land, which need incentives and clear methods of engagement to encourage investments in commercial forestry on private land. The policy statement is to promote private sector participation in establishment and management of plantations through appropriate forest management arrangements and incentives and promote species diversification through planting of indigenous and exotic species with proven potentials (Forest policy, 2015).

Over the last few decades, policy makers have advocated and applied forestry decentralization as an appropriate means of environment protection and sustainability. (Anderson, 2006).This has often been done with the motivation to increase the involvement of forest based communities and local institutions in forest resource management. Their assumption is that the local people's involvement in forest resource governance is the most appropriate means of ensuring sustainable forest resource management and green development (Robert and Larson, 2005, Ribot and Oyoro, 2006). In pursuit of its commitment to reverse the degradation of forest for examples, the government of Ghana, in 1996, launched the forestry and wildlife master plan to reverse deforestation between 1996 and 2020 which is estimated at 65,000 ha per annum (Forestry Commission, 2001).

Against this background, the forestry sector in Ghana has implemented a number of decentralized schemes (Marfo, 2004). One of them for which the issue of livelihood development and forest reclamation are so crucial is the modified Taungya system (MTS). In 2001 the government Ghana launched the MTS as a decentralized mechanism to halt and reverse degradation of forest resources as well as build community resilience for enhanced

rural livelihoods and poverty reduction. The MTS is a decentralized forest management strategy in which communities are given portions of degraded forest reserve to inter-plant food crops with trees and further nurture trees into maturity under an agreement in which costs and benefits sharing are specified .In this arrangement the forestry commission of Ghana transfers responsibilities to selected forest fringe community members and established local authorities as partners both in managing and drawing benefit from forest reserve to ensure local communities commitment to sustainable forest governance. After over a decade of the MTS, implementation its viability to achieve or deliver livelihood security, forest resource recovery and poverty reduction at the local arena require monitoring and verification (Prince Osei *et al.*,2008).

The Modified Taungya System (MTS) involves the establishment of plantations by the government (FC) in partnership with farmers. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The farmers are allowed to cultivate food crops which are planted between the trees on the same lands. As the farmers does all the labour while not getting paid for it. They will have a share in the future timber revenue. They are entitled to 40%, whereas the government also gets 40% and the land owner and community will obtain 15% and 5% respectively. Many farmers in the MTS are migrant farmers; they go back after 2 years. So the plantations are abandoned, which is not good for the trees as they need to be maintained. It is better for the plantations that the stay for a longer time. The original Taungya system was modified and extended with the benefit sharing scheme because the scheme was boycotted by the farmers due to lack of benefits and voice (Interview Zonal plantation managers of the FC, 2010). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

In recognition of the important role that increased forest cover and food security plays coupled with the challenge of inadequate funding towards forest plantation establishment. The government of Kenya through (KFS) modified "shamba" system which for a long time has been used to raise forest plantations where the forest adjacent communities through

(CFA) benefit from cultivation of food crops in the forest during the early stages of forest plantations establishment of forest plantation at a low cost (Mwatika *et al.*, 2013). Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced as a policy guideline to address the decreasing trend of forest cover. The scheme has been used to establish forest plantations since 2007.

A review of the past studies on the shamba system shows that success and failures depends on how well government guidelines are implemented and enforced when the system was reorganised in 2000, success rates climbed and again recede after the 2003 ban. Funds allocated to the FD for forest operations are grossly inadequate declining from kshs 390 million in 1996 to 95 million in 2004. Though planting has increased, fewer seedlings are surviving, rates have declined from as high as 90% to as low as 10% in some stations (Kagombe *et al.,* 2005).

Since 1968, the country has experienced a major decrease in forest cover which has resulted in reduced water levels, bio diversity, supply of forest products and habitats for wildlife. Also according to sessional paper No 1 of 2007 on forestry policy, the forest sector has been faced with conflicts between forest managers and forest adjacent communities over access to forest resources. In response to increasing back logs and adequate resource capacity within the forest department to reestablish plantations, the shamba system was reorganized and reintroduced in a few districts as NRC in 1994.

2.4 Plantations Establishment and Forest Cover.

Nair (1985) indicates that, in case of severe deforestation, programmes are important to restore the tree cover. When plantations are established, they can provide a sustainable tree cover, but working at the biodiversity and environmental services compared natural forests, the plantations are poor in supplying them. Forest plantations have more potential to grow food crops, as the space between the trees can be used to grow food crops during the first years of plantation establishment. This could be beneficial for people who live and work in forest plantations. So plantation establishment development can be seen as part of agriculture, more specifically as specific type of agro forestry, namely an agrosylvicultural system.

Various options exist for plantations establishment for higher growth and survival rates. Total cultivation though expensive is the most appropriate .In the absence of more resources, NRC is the most viable method. A well-managed NRC has a similar effect to total cultivation ,costs are shared by the community and the forest department and both benefit

(Kagombe *et al., 2005*).without viable alternatives in sight the government should review the ban on NRC in areas where it has been working and establish mechanism to make it work in areas where it has failed .Further to that the FD must recognize the importance of community participation in forest management and in particular the role of the NRC management committees (Kagombe *et al.,* 2005). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

The Kenya forestry sector is today characterized by the problem that the rate of forest estate clear fell does not match the rate of replanting. This results in a rise to backlogs in plantation establishment. For example, of the 170,000 hectares of government owned forest plantations, 20,000 (12 %) hectares are open land or where recently felled and not replanted. Backlogs in forest plantation establishment refer to delayed operations in tree establishment and tending. By 1995 there were a total of 17657 hectares of planting backlogs, 1338 hectares of thinning backlogs, 22,750 hectares of pruning backlogs and 2175 hectares of coppice reduction backlogs (Wanyiri report, 1995). The Ol bolossat forest had over 1000 hectares of forest planting backlogs due to unsustainable tree harvesting and poor plantation establishment but the CFA through PELIS has reduced the backlog to less than 300 hectares (KFS, 2011). Most of the natural forest suffered degradation but now the communities are carrying out rehabilitation of degraded catchment areas.

The aim of KFS plantation programme is to have a sustainable production of forest products that will satisfy the present and future demand. This can only be ensured by timely replanting of harvested plantation areas. In recognition of the need to increase the forest cover in Kenya, the government through sessional paper no.1 of 2007 on forest policy provides guidelines for intensified tree planting inside and outside gazetted forests. Availability of high quality tree seed is key to realization of this policy. Seed quality is assured through KEFRI who is mandated to provide certified, site appropriate, high quality tree seeds in sufficient quantities to meet the national demand. KEFRI endeavors to best practices throughout seed production chain to ensure provision of high quality seeds (KEFRI, 2011). CFAs helped in tree operations and raised some 10.5 million tree seedlings during 2011/2012 compared to 5.8 million seedlings raised by KFS alone per year (KEFRI, 2011).

When the presidential ban came into force in 1999, the planting backlogs stood at 46,000 hectares but replanting efforts have since reduced it to 15000 ha. From 2002 to date

20,000 hectares of industrial forests plantation have been established through PELIS in gazetted forests all over Kenya. During the financial year 2011/2012 KFS had 16, 281 hectares of forests plantation under PELIS. The higher survival rate from 20% to 80% was due to better care for tree seedlings by PELIS farmers and improved forest governance by KFS. Improved tree cover has contributed towards achieving vision 2030's target of 10% forest cover which currently stand at 6.9% of the total land area.

KFS (2007) confirms that, the established young trees are from certified seeds, grows at high rate, fixing an average of 2.7 m3 carbon per hectare from one to age four. This leads to clean environment and reduction of global warming as stipulated in the Millennium Development Goals (MDGs, 2001). Shamba system (PELIS) is allowed under the Forest Act 2005 and is recognized as one way of raising plantations. One way to ensure that people benefit from forest is to allow system such as this, which benefit both the government and farmers.

Those plantation established under monoculture regime interfere with the forest biodiversity, and reducing its water catchment qualities. Farmers have been told to keep off indigenous forests. The noble peace prize laureate Prof. Wangari Maathai contends that "We cannot sacrifice indigenous forest at the expense of exotic plantations". Plantations represent a monoculture of trees, but a forest on ecology system. Maathai affirmed ‘' we are destroying local diversity and greatly the capacity of the forest to be effective water reservoirs (Paulo M, 2010). Forest scarcity induces higher prices of forest products, which encourage both better forest management and the establishment of woodlots and plantations. (Rudel *et al*., 2005) refer to this as the forest scarcity path, which forms the other main route towards forest transition. The success story of Machakos in Kenya provide an example (Tiffen *et al*., 1994)

On the Kenyan side, where piloting a livelihood plantations are being piloted under the PELIS, the system is dominated by maize rather than trees, with respect to quality, the tree will grossly under perform in terms of yield o timber of transmission poles, which people hope to sell at the end. Generally the PELIS approach as it is being implemented now will yield limited benefits in terms of improving forest cover and forestry products and services,

2. 5 Plantations Survival Rate and Forest Cover.

According to Kagombe *et al*., (2005) to attain an increased forest cover, the survival of the planted tree seedlings must be guaranteed. And this is possible through PELIS. As the farmers tend their crops by removing weeds and adding fertilizers the saplings too benefit as

they are not subjected to competition for nutrients with weeds and also they get nutrients from fertilization hence increased survival rate. Given that hygiene of the seedlings is secured through PELIS, higher survival rates for seedlings and lower susceptibility to pests and diseases.

The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004). It is paramount that to achieve a sustained forest cover from PELIS, then law enforcement efforts must be doubled. This will ensure that illegal activities that degrade the forest i.e. deforestation are controlled. The programme PELIS is improving tree cover in gazetted forest areas since it helps to improve survival rate and establishment of forest stands (M Nichlon, 2000). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012).

The reason for committing forest offences are often because of ignorance of the law and negligence They also include poverty, unemployment and the collections of medicinal plants for commercial purposes. Widespread bribery of forest guards and local police, lack of support to junior officers, shortage of vehicles and other equipment in the field to collect evidence of infractions and inadequate fines or sentencing continue to hinder enforcement efforts (World Bank, 2007 a) and create conflict between the authorities and communities in many natural forests.

Although the command and control approach of the past emphasizes law enforcement rather than crime prevention, low enforcement rather crime preventions, KFS understands that it must integrate compliance measures with greater efforts to involve communities in forest management which includes PELIS (Geller *et al.*, 2007). As the farmers tend their crops they also protect the young and the old trees from illegal poaching and destruction. The hygiene they keep in the PELIS areas also help in keeping off pests, diseases and also reduce incidences of fire outbreak. It is recognized that the current trend in forestry management is to move towards participation of communities in management of forest resources. It is difficult to police forests especially in areas where high population surrounds it. The communities are therefore involved in conservation and protection.

The way forward for shamba system is to consider it as a form of joint forest management where the communities will get shamba and in return participate in forest protection, adequate funding of forest protection, KFS enforcement and CFAs in terms of remuneration and housing facilities (KFW, 2013). At this rate of reward it is clear that maintenance of the plots in the second year and third year will be carried out by Taungya farmers. Given that they themselves hire labour for some activities; it is reasonable to assume that they might do the work if the reward matched the market rate. An alternative method of payment would be on a per seedling, survival basis, pro rata. (M K Mc Call and M M Skutsch, 1993).

On the whole the per seedling method is more likely to give satisfactory results, although there will be cases of hardship due to drought and difficulties especially if farmers have land of unequal quality. (M K Mc Call and M M Skutsch, 1993) Growth of the planted areas under shamba system has been reported to be higher than unattended tree plantations (Pudden, 1953, Konuche and Kimondi, 1990). This is contrary to the earlier view, which claimed that growing trees under Taungya reduce the growth (FAO, 1967b)

In Ngare forest station, Nyeri, the forester noted that CFA participation was saving the government a lot of money due to reduced cost of seedling production, tree planting and tree protection. He indicated that a plot of 100 hectares of planting backlog, 70,000 seedlings were needed and these would have cost KFS about 1.4 million. However, KFS was only compensating the community with Kshs 300,000, hence saving Kshs 1.1 million (Kagombe, 1998).

The farmers who have been part of community Forest Associations have been very helpful in managing and protection of the forest "when we plant trees in the forest the farmers have played a key role in the forest positively in line with the Forest Act 2005 which mandates that we work hand in hand with communities' said Mr. Chege. He added that KFS and the farmers have been collaborating and encouraging the PELIS scheme which enables farmers to plant crops in forest area for three years as they tend seedling, this arrangement has been very beneficial and has ensured 100 percent survival of the planted tree seedlings (KFS, 2014).

Mr. J. Mwanzia, the project manager (GZDSP) expressed satisfaction by the efforts of the community through protection of forest particularly against forest fires. "As we were starting out, there were perennial forest fires as is common with forest during dry seasons and during those times communities offered us little and sometimes no help at all, but since

engaging them directly we have experienced total change of attitude as the communities are first to spot fire and put it off even before involving the forester “said Mwanzia (KFS, 2014). When farmers dig out the mature potatoes, they are cautious not to hurt any of the seedlings. They are growing the produce in state land within, the forest gazetted zone (R. Manyaka, 2015). We play a great role in conserving the environment around the area. And that is why when we plant the tree seedling, we work so hard to ensure they survive” she noted. (R.Manyaka, 2015). Trees grown under the PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI, (R.Manyaka, 2015).

2.6 Cost of Plantations Establishment and Forest Cover.

One of the key objectives of PELIS was to reduce the cost of plantation establishment that currently stand at Kshs 54,500 per hectare at three years using the pitting and spot weeding method as compared to about Kshs 30,350 per hectare under 'shamba' system (KFS, 2007). KFS will benefit from this scheme by saving money that would otherwise be used for land preparation and subsequent maintenance of the planted areas which will be utilized in other conservation programmes. (Chamashama, *et al.* 1992) observed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial income to the peasant farmers and reduction of forest plantation establishment costs.

Enabor (1979) observed that, introduction of Taungya system into the humid tropics was a response to various socio-economic factors. For example in Nigeria, a major objective was to solve the problem of high cost of forest regeneration. One benefit of shamba system is low cost of plantation establishment. Taking wage of kshs 80.00 and current task rates, costs of establishment of plantation per hectare compounded at 15% to the end of 30 years rotation, was found to be approximately kshs 277, 000 for NRC areas. This means NRC is critical to economic development of plantations (World Bank Supervision Report, 1996). In 1990's FD reduced its staff through the retrenchment programme, which had an aim of reducing government expenditure. This means only a skeleton staff remains in the forests stations (Kagombe, 1998). Tree planting is faster as opposed to natural regeneration but a more costly way of restoring forest cover. Forest recovery is a slow process and when time is important forest plantations are economically and ecologically good alternative (Lugo, 1992). The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the

labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The study by G C Monela,, *et al*., 1991 on analyzing the taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

The cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. The table below shows the cost of plantation establishment for each method by 2007. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. However, the system was abused such that prohibited farming tools were used like non-specified crops were planted and penalties for wrong doers were not honoured especially for those who rented out plots to outsiders who were not interested in conservation (FD, 2005). Effective cost/benefit sharing of forest resources e.g. through introduction of PELIS to reforest indigenous forest areas is a positive step. This could be adopted within the REDD+ framework (MFW, 2015).

Table 2.1: Task rates from FD (2005)

Activity	Total cultivation shs	Slashing shs	Slashing and spot hoeing shs	No preparation shs
Clearing	10,000	35,000	45,000	0
Staking out	1,500	1,500	1,500	1,500
Planting spos	1,500	3,000	3,000	3,000
Planting	1,500	1,500	1,500	1,500
Yr 1 tending	10,000	3,500	4,500	0
Yr 2 tending	10,000	3,500	4,500	0
Yr 3 tending	10,000	3,500	4,500	0
Total cost	**44,500**	**51,500**	**64,500**	**6,000**

Source: Task rates from FD (2005)

2.7 Livelihood Improvement and Forest Cover

Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and the survival of plantation trees, it has also provided other significant benefits such as making available arable land for the landless and contributing to food production. Plantation establishment and livelihood improvement scheme (PELIS) a modified form of non-residential cultivation that was practiced in earlier years in Kenya as a method of plantation establishment GOK, 2005; GOK, 2006;FAO, 2006). PELIS was initiated with the objectives of fully rehabilitating and protecting the forest and improving the livelihood of the forest adjacent communities (GOK, 2005). According to (Kafu, 2002) the expected benefits from PELIS were numerous. First, there would be increased forest cover, increased volume of water from the catchment areas, increased food production and there would be improvement in living standards of the communities living adjacent to forest due to increase in household incomes (GOK, 1994). PELIS is meant to improve economic gains of participating farmers while ensuring success of planted trees.

Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water

resources which loses its quality as forests condition worsens (MEA, 2005). Fresh water catchment and soil preservation are important inputs to agriculture and food production. FAO should also arrange with the government of Kenya as host of the FAO regional conference for Africa (March, 2008), to include the key role of forestry in achieving food security on the agenda. (Geller *et al.*, 2007).

V.K. Agyemen,2003, also noted that food crops, especially annuals such as plantain, Cocoyam and Vegetables were interplanted with determined trees species. The food crops were normally cultivated for three years, after which the shade from the trees impeded further cultivation of the crops. Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

Apart from successes observed through the MTS in the regeneration of degraded forest resources, the livelihood assets received by local people through the MTS intervention have led to significant increase in food productivity, income levels and general well-being of most households in all communities studied (Osei W and Eshun G, 2013). Interventions such as the MTS reveal that central governing agencies alone cannot have adequate capacity to combat deforestation and forest degradation or even monitor it. Local peoples' participation becomes a necessity for the implementation of the REDD+ intervention and related climate change mitigation measures to be effective (Osei W and Eshun G, 2013). Under the traditional taungya arrangements, Ghanian farmers had no rights to benefits accruing from the planted trees (Milton, 1994) and no decision making role in any aspect of forest management (Birikarang,2001).

A case study done in Njoro area East of Mau forest indicated that farming community in this area utilize the plantation area to grow food crops especially vegetables during the dry season. (B, Wangwe at el). Shamba system gives high return to farmers by close to Ksh 120,00 per hectare per year it creates employment to farmers and ensures food security.

(Kagombe, 2009). Forest management is important for people who gain a livelihood from the forest because people can only have a stable source of livelihood if forests are sustainably managed. In that way people can overcome their vulnerability based on forests (Hoogenbosch, 2010)

The project (GZDSP) has improved the livelihood of the communities living adjacent to forests through support of income generating activities (IGAs) which they depend on for survival. The model they engage in while rehabilitating degraded sites is Plantation Establishment and Livelihood Improvement Scheme (PELIS) which provided for communities to cultivate the forest area and plant crops for up to three years as they tend for the seedlings in the rehabilitated area. Mr. Kemau of the many beneficiaries said that the project activities enabled him buy a motorbike and purchase a ten acre piece of land in Gathiuru which he has started to construct. The communities utilize grazing rights, PELIS and fuel wood collection among other forest activities (KFS, 2014)

Kenya Forest Service Director, Mr David K. Mbugua on 10th may 2014 made a tour of Olbolossat forest, Nyandarua Zone to view the progress on areas of forest plantation under the CFA using PELIS that spell from 2009 to date. From the same unit of forest land a total of approximately 3,500 community forest Association members of which 2000 are able to generate profit from sale of crops while the remaining 1,500 benefits from grazing and other activities, have made Olbolossat success story. The next day the board visited Timboroa Forest station where they were received by members of the community led by CFA officials who took the board through the benefits they have enjoyed from their symbiotic relationship with the service in the form of PELIS.

In the nearby Nabkoi Forest station the board also saw the huge plantation backlogs that are typical of many areas where a shortage of resources caused backlogs (KFS, 2014). Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and survival of the plantation trees, it has also provided other benefits such as making available arable land for the landless and contributing to food production (Paul Okelo Odwori, Phillip M. Nyangweso and Mark O. Odhiambo, 2013). Under PELIS, CFA is allocated a piece of forest and where plantation trees are intended to be raised. The CFA shares it out among its members with each paying a small royalty. The farmers grow crops for food and for sale. In the second year (season) the farmers' plant preferred trees with the aid of KFS managers on the same piece of land.

In this way, farmers improve their food security, have some surplus for sale to get

income and their livelihood improve. (D. Walubengo and M Kinyanjui, 2010). It is a joy for farmers to benefit from PELIS as some people small pieces of land whose productivity is low can now generate enough profits to raise even wealthy families (R.Manyaka, 2015). Wanyoike said that since 2005, they have been farming on portioned acre producing high volume of potatoes and thus fetching good returns hence has significantly improved their living standards. “We have uplifted our living standards and we are so happy about it. Having a piece of land here (Aberdare Forest) to farm has created employment for us and we are making good profits” she said.

‘The MTS has been of immense benefit to the entire community, I could find majority of the youth in senior high school because their parents are now able to afford .Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small. Almost every member of this community involved in the MTS is able to grow more food stuffs for their household's consumption and for sale to earn some money to take care of their households. As for the trees we are willing to plant more and manage them well all we need from government is for us to have land and released to us on annual basis. Because we know that when trees are well taken care of ,they protect ourselves and the 40 percent benefit to MOTAG farmers who manage the trees well until maturity can support our children in the future EVEN when we are not alive" (Prince Osei *et al*., 2008).

Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars. “PELIS is offering communities an economic boom. Many CFAs are making millions from cultivating in the acres allocated to them” said Simiyu Wasike, deputy Director in charge of plantation and enterprise at Kenya Forest service. It a system promoting, plantation establishment, food security and better livelihood in the country and more than 185 CFAs exist in the country summing up the members exceeding 10,000 Wasike says (R. Manyaka 2015). Gerald Ngatia executive director for National Alliance for community Forest Association (NACFA), says successful PELIS is a major boosts to hundreds with of small scale farmer across the country. ‘Not only does PELIS create jobs for many but it greatly contributes to food security in the country. “Said Ngatia (R manyaka 2015).

2.8 Theoretical Framework

This study related two theories i.e. forest transition theory and environmental Kuznets curve theory.

2.8.1 Forest Transition Theory (FT)

The theory describes a sequence over time where a forested region goes through a period of deforestation before the forest cover eventually stabilizes and start to increase. This sequence can be seen as a systematic pattern of change in agricultural and forest land rents overtime. Increasing agricultural rent leads to high rate of deforestation. In describing how forest cover changes through the development phases of a country, this concept of forest transition is useful in depicting such changes. In that regard, the forest transition (FT) model describes the overall human induced changes of forest cover overtime and basically presents the combined effect of various drivers of on a national scale. The concept was proposed and articulated by Mather (1992) and later expanded by Rudel (2005) and (Kauppi *et al.*, 2006).

The model basically shows the transition in which a country with 40% forest cover goes through phases of decreasing forest cover through human activities till a period of maximum decrease before a country realizes that it can no longer afford to lose more forest cover and at which time, it begins to stop further net loss of forest cover and put in policies and measures to increase forest cover, in the case of Kenya the policy is PELIS. Graphically the trajectory is described at the national level by inverse J-shaped curve overtime. Furthermore the entire inverse J-shaped curve can be broken into four phases namely: pre-transition, early transition, late transition and post transition phase. These phases generally represent a time sequence of national development (Hnosuma *et al.*, 2012).

In Africa subsistence agriculture remains the dominant driver but the effect of commercial agriculture is likely to increase in early transition. Countries such as Angola, DRC, Zambia and Mozambique with respect to forest degradation, logging accounts for 52% fuel wood and charcoal 31%, fire 9% and livestock grazing 7%. The Kenya forest service can use its position on the curve for purposes of policy advocacy for the forest sector in general and for REDD+ in particular. Honosuma *et al.*, (2012) observed that the phases of transition are associated by drivers of varying significance as listed herein;

1. Agricultural expansion dominates the early and the late transition phases.
2. Fuel wood and fires- become more dominant in late and post transition phases.
3. Subsistence agricultural- fairly stable over all phases.

4. Urban expansion-largest in the post transition phase.

In general, nature the study notwithstanding, the study by Honosuma *et al*. 2012 places Kenya in the late transition phase in generalizing transition curve.

2.8.2 Environmental Kuznets Curve Theory

The second theory that also relates to forest cover is environmental Kuznets curve that contends that a U-shaped relationship exists between environment quality and economic development. The theory relates forest cover as key indicator of environmental quality and income levels.

2.8.2.1 Forest and the Natural Environment

Forests have been a source of life from time immemorial. A part from being the basis for a variety of wood and non-wood products and services forests are home to many forms of life and an essential role environmentally, including climate regulation, carbon recycling, bio diversity preservation and soil and water conservation. Biodiversity is widely recognized as a major source of sustainability, indicator may be identified to help detect human impact on nature including the health of ecosystem, the functionality of watersheds and so on.

2.8.2.2 Environmental Quality and Economic Well being.

On the basis of framework of Kuznets (1955) proposition asserts that economic growth may be harmful to the environment before reaching a certain stage but becomes conducive afterwards. Hence the relationship assumes a U-shaped. (Arrow *et al*. 1995).. The curve indicates that as the economy grows, environmental degradation increases up to certain level after which environmental quality improves. This means that at low income levels, environmental quality tends to decline along with economic growth, but ultimately improves as income levels rise beyond a threshold. The U-shaped relationship is dictated by the ability to spend on environmental amenities implying that wealthy countries have lower levels of environmental damage because they can afford to pay for environmental improvement, whereas poor countries cannot afford to emphasize amenities over material well-being.

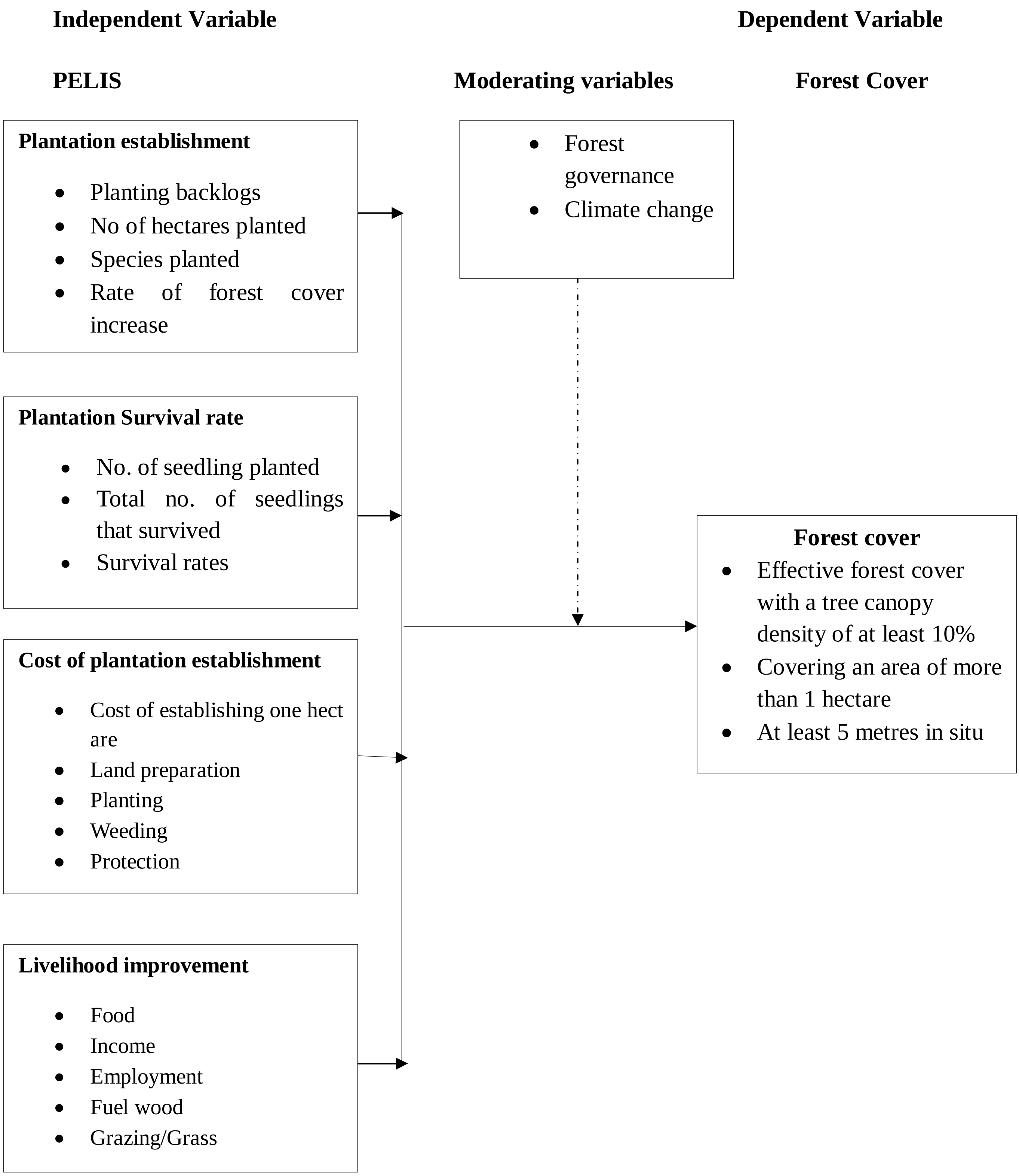
2.8.2.3 Is Forest Cover Related to Income Levels?

Human beings depend on forests for a variety of purposes. Population growth results in higher demand for forest based products and services. Therefore, it is reasonably to

postulate that population increase is a fundamental driving force of change in forest cover. (Mather *et al*. 1999) suggest that there is a theoretical basis for linking long term trends in forest use with economic developments including the emergence of forest transition as a society's income rises. Change in the state of the forest is subjected to a certain set of appropriate and constraints and income levels. From the perspective of developing countries, unless the gap between global diversity benefits and the needs of local people is narrowed the required economic growth will occur at the expense of much of the planets biodiversity (Fuentes-Quezada, 1996).

2.9 Conceptual Framework

Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced in the Kenya's forestry sector to specifically alleviate planting backlogs, increase plantation survival rate, reduce cost of plantation establishment and improve the livelihood of the adjacent communities through food security. Its overall key objective was to increase the forest cover. The table below shows the two variables and their indicators.



(Source: Researcher, 2015)

Figure 1: Conceptual framework

Independent variable is PELIS while dependent variable is forest cover in this study. There are four factors that influence forest cover, and they include; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. The PELIS indicators would be the number of hectares planted, plantation survival rate, the cost of plantation establishment and the number of bags of maize and potatoes harvested. While on forest cover the indicator would be the area under forest cover in percentage. However, there are some other external factors that may behave like independent variable and has contributory effect on the relationship between independent and dependent variables. They include; forest governance and climate change factors. These factors could be termed as moderating variables.

On forest governance, if there are no proper rules, regulations, policies and code of ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, and prolonged dry spell. These will eventually lead to forest destruction and degradation hence forest cover loss.

2.10 Gaps in Literature Review.

The literature review on PELIS covered by this study has largely focused on its influence on food security to the forest adjacent communities and availing arable land to the landless. A wide knowledge gap of PELIS influence on forest cover is conspicuously missing and if available but only by mentioning. It is on this backdrop that this study will come handy for the policy makers in making informed policies and decisions besides ensuring sustainable production of the various forest products and services to the forestry sector players in the country.

MFW (2012) identified lack of clear policy on cost and benefit sharing that is not covered in the current Forest Act 2005. This is hindering afforestation and protection efforts by the key stakeholders as they feel they are short changed. Need for review of technical orders on spacing to increase the time farmers cultivate plots before canopy closure. Lack of stringent harvesting procedure is also escalating over logging, this include lack of felling and plantation establishment plans or look warm implementation in areas where they exists. (MFW, 2012).Lack of incentives to CFA members involved in PELIS make them less accountable to the programme rules and regulations. Conflicting sectoral policies e.g. Water

Act, Agricultural Act and EMCA, 1999 Act on wetlands protection. All these needs further research so as to ensure that all these bottlenecks are addressed.

Table 2.2: Knowledge Gaps

Thematic area	Author (s)	Method	Main findings	Knowledge Gaps
Influence of plantation establishment and livelihood improvement scheme on livelihood of Gaithiuru forest, Nyeri.	Mwatika N M (2013)	Descriptive research design that targeted CFA member	Study found that PELIS had a positive influence on livelihood of forest adjacent communities. The scheme diversified sources of livelihood, enhanced social and human capital.	The researcher did not study the influence of PELIS on forest cover. This study will explore how PELIS contribute to forest cover through enhanced area established with plantation.
Forest reclamation, REDD readiness and community livelihood sustainability. Assessing the viability of modified Taungya system as a decentralized Nature governance strategy.	Prince Osei Wusu Adjei and Gabriel Eshun (2008)	Survey method that targeted a total of 150 respondents in four forest fringe communities in a district in Ghana about their own forest and how it is governed.	Community participation in forestry decisions through the MTS enhances community resilience to combat climate change through improved community forest cover and livelihood.	The research targeted on modified taungya system as adecentralised nature governance strategy. This study will focus on the influence of PELIS on forest cover through plantation establishment, plantation survival rate and costs of plantation establishment.
Plantation establishment in Kenya – The shamba system case study	Joram K Kagombe and J M Gitonga (2005)	Survey method that targeted selected five districts	Total cultivation for plantation establishment is expensive but gives the highest survival and growth rate .	The study never focused on the influence of NRC on forest cover. This study intends to determine how much area has been established through use of PELIS

Challenges facing forest plantation establishment through shamba system; the case of Mucheene forest.	Ikiara, Isaac G (2010)	Survey method that targeted cultivators of six CBOs	There was adherance to the shamba system policy guidelines and community participation.	The study did not establish the influence of plantation establishment, plantation survival rates and cost of plantation establishment on forest cover.
Alleviating Food Insecurity and Landlessness Through PELIS in Kenya	Paul O. Odwori, Phillip M. Nyangweso and Mark O. Odhiambo (2013)	Purposive sampling was used to identify forest zones that practice PELIS in Kenya	PELIS contribute up to 2,049 hectares of arable land to the landless and up to 3 million bags of maize	The researcher did not focus on the influence of PELIS in increasing forest cover hence basis of this study.

2.11 Summary of Literature Reviewed

The study gathered literature from a wide range of authors whose studies were mostly based on the influence of PELIS on the livelihood of the forest adjacent communities but not on forest cover. PELIS has a number of components, some of the key components highlighted in this study include: plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. During literature review the four components were found to influence forest cover. With regard to the influence of plantation establishment on forest cover the literature reviewed showed that indeed there is influence but was not discussed at length. On influence of survival rate on forest cover many authors established that well weeded, fertilized and protected plantations improved survival rates. Little literature was established with regard to the influence of cost of plantation establishment on forest cover, as farmers were providing labour for free from land preparation to protection and this was made possible because farmers were tending their crops too. Most researchers reviewed literature on the influence of PELIS on livelihood improvement of the forest adjacent communities but not livelihood improvement on forest cover. It is therefore important that the literature reviewed in this study will go a long way in bringing out the link between PELIS and forest cover.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The chapter entails research design, target population, sampling design / procedure, sample size, data collection instrument, data collection procedure, measurement of variables, reliability test, and validation of instrument, data analysis, anticipated outcome and ethical considerations.

3.2 Research Design

This study explored survey research design. .It uses primary and secondary sources and qualitative data sources e.g. diaries, official records, reports etc. Survey is the systematic means of collecting information from people that generally uses a questionnaire (Grewal and Levy, 2009). Given that the study largely relied on the secondary data from the government offices and administering of interview schedules and questionnaires to the forest managers and the CFA members respectively hence it was necessary to use the research design.

3.3 Target Population

Target population was 6521 which included 6515 CFA members and 6 forest station managers. The study focused on plantations established 2001-2007, without PELIS and plantations established 2008-2014 with PELIS.

Table 3.1: Target population

Strata	No of CFA members	No of forest station managers	Total
Kapsaret	403	1	404
Cengalo	1650	1	1651
Nabkoi	1804	1	1805
Kipkurere	852	1	853
Timboroa	1406	1	1407
Lorenge	400	1	401
Sub –Total	**6515**	**6**	**6521**

3.4 Sampling Procedure and Sample Size

3.4.1 Sampling Procedure

Simple random sampling method was used in the two population groups because it is considered simple, most convenient and bias free. Every member of the population has equal and independent chances of being selected as respondents (Frankel *et al*, 2000). Sampling is a procedure of selecting a part of the population on which research is to be carried out, which ensures that conclusions from the study can be generalized to the entire population. Since the forest station managers were few, the researcher used non probability technique which is purposive sampling design to select the six forest station managers. (Leedy, 1993) observed that nothing comes out at the end of a long and involved study that is any better than the careful selection of the population using random sampling and stratified random sampling.

3.4.2 Sample Size

Given that the target population is less than 10,000 hence to calculate the final sample (Nassiuma 2000) sample size formula will be used. According to (Nassium, 2000) in most surveys , a coefficient of variation is the range of 21% ≤30% and standard error in the range 2% ≤ e ≤ 5% is usually acceptable. Therefore the study will use a coefficient variation of 30% and a standard error of 2%. Nassium (2000), gives the formula as follows; $n=Nc^2/c^2+(N-1)e^2$. Where; n= Sam ple size, N= population, c= covariance, e= standard error.

$$n = \frac{6515(0.3)^2}{0.3^2+(6515-1)\ 0.02^2} = 218.$$

Target population sample size is 218.

By using this formula a sample size of 6 and 218 for forest stations and CFA members will be used respectively. Below, is the table summary for target population in each study area and corresponding sample taken from each area. The study will use Neyman (2000) formula for stratum sample size allocation, Nh - (Nh/N) * n where sample size for stratum h, Nh= population size stratum h, N = total size of population, n= total sample size.

Table 3.2: Sample size for target population

Strata	**CFA Members**	**Sample Size**	**Forest Managers**	**Sample Size**	**Total Sample Size**
Kapseret	403	14	1	1	15
Nabkoi	1650	55	1	1	56
Cengalo	1804	60	1	1	61
Kipkurere	852	29	1	1	30
Timboroa	1406	47	1	1	48
Lorenge	400	13	1	1	14
Sub-Total	**6515**	**218**	**6**	**6**	**224**

Random sampling method was used to sample the CFA members for each forest statio n .This was done by assigning random numbers to them.

3.5 Data Collection Instruments

The study employed both primary and secondary sources of data, which included questionnaires, interview schedule and personal observations. In the case of secondary data, office records like statistical reports, scholarly journals, thesis, diary, and pamphlets, were used as well as Worldwide Web, text books, newsletters and magazines. Questionnaires as a primary source was used for data collection from the CFA members and interview schedules were used for forest station managers .A questionnaire is a form that features a set of

questions designed to gather information from respondents and whereby accomplish the researchers' objectives (Grewal and Levy,2009).

The questionnaires were structured. It is relatively economical method in cost and time, of soliciting data from a large number of people and the time for checking on facts and pondering on questions can also be taken by respondents, which tend to lead to more accurate information (William, 2005). Each item in the questionnaire is developed to address specific objectives, research questions or hypothesis of the study. The respondent is expected to react usually in writing. It assists in collection of information over a short period of time when time is a limiting factor.

The researcher personally together with competent assistants administered the questionnaires and the interview schedules so as to be assured of relatively uniform mode of questioning and questioning and subsequent respondents. The questionnaires were in two parts, Section A was about demographic information and Section B was about CFA food production activities through PELIS and plantations establishment 2001-2014. The study also employed face to face interview and personal observations from the six forest station managers to get clarity on some secondary data gathered from the office records. The reason for using interviews was that they are easy to administer since questionnaires are already prepared .The investigator follows a rigid procedure and sought answers to a set of pre-conceived questions through personal interviews (Kothari, 2004).

They also eliminate many sources of bias common to other instruments. This is because questions asked are usually confidential between the researcher and the respondent. Interviews clarify points that are not clear, collected from key informants by use of interview schedules. Interview schedule is important because it helps eliciting in depth responses that may enable deep understanding of the research problem. The interview schedules are comprised of A which is about demographic information while section B up to F about the four study objectives. Personal observations will also be employed in assessing the status of the plantations. This is where the researcher uses all the senses to perceive and understand the experiences of interest. It gives firsthand experience without respondents information as it occurs, explains topics that may be uncomfortable to respondents and notice unusual aspects. The researcher uses an observation checklist to record what he observes during data collection.

3.5.1 Pilot Testing of Instruments

A pilot study was carried out at one of the six forest stations and it's CFA. This was purposely to confirm the reliability and validity of the research instruments .The researcher also verified that ambiguous information was removed while deficiencies and weaknesses were be noted and corrected in the final instruments (Croswell & Miller; 2000). The main aim was to ensure clarity and suitability of the instruments that were used in the study. Reliability and validity is about usability of the instruments as it is about ease with which instruments can be administered, interpreted by participant and scored/interpreted by researcher. Usability considerations include how long it will take to administer, are directives clear, how easy is it to score etc.

3.5.2 Validity of Research Instrument

It is the extent to which an instrument measures what it is supposed and performs as it is designed to perform. This involves collection and analysis of data to asses accuracy of an instrument. It is prudent to use instruments from previous studies to ascertain content validity. It is one that has been developed and tested several times. It is about appropriateness of the content of an instrument. It should measure what one wants to know. To confirm this both the questionnaires and the interview schedules were tested by administering the same.

3.5.3 Reliability of Research Instrument

It refers to stability or consistency of measurement; that is whether or not the same results would be achieved if the test of measure will be applied repeatedly (Someh and Lewin, 2007) Reliability test of the instruments was done using cronbach alpha co-efficient. Nunally (1967) suggested that the minimal uptake reliability of 0.7 is recommended. To ascertain the reliability of the questionnaires, the researcher administered 10 questionnaires and two interview schedules for two CFA groups and two forest managers respectively. The modes of responses to the instruments were consistent and even time taken to answer the same.

3.6 Data Collection Procedures

The process of data collection commenced once the necessary certifications had been completed. The researcher sought permission from National Council for Science and Technology and finally got authority from the County Commissioner, Eldoret to carry out

research in the identified area. The researcher personally with the assistance of competent assistants administered the research instruments to the respondents after familiarization and informing the respondents of the purpose of study. Appointments were booked for various dates for data collection. The interview schedules for forest station managers were personally administered by the researcher. He also personally together with the assistants distributed the questionnaires and the completed instruments were verified and collected from the respondents.

3.7 Data Analysis

The data collected from both primary and secondary sources were checked for completeness, accuracy and relevance. SPSS was used to analyze the data. Descriptive statistics were used in analysis and presented in tables, frequencies and percentages. Also used were measures of central tendencies and dispersion where applicable.

3.8 Operationalisation of Variables in the Conceptual Framework

Table 3.3: Operationalization of Variables

Objective	Indicator	Measurement Scale	Tools of Analysis
To establish the influence of plantation establishment on forest cover in Uasin Gishu county.	-No of hectares established -No of species planted	Ratio Nominal Ordinal	Means, frequencies and percentages
To determine the influence of plantation survival rate on forest cover in Uasin Gishu county.	-No of seedlings established -Total number of seedlings that survived	Nominal Ordinal	Means, frequencies and percentages
To investigate the influence of cost of plantation establishment on forest cover in Uasin Gishu county.	-Cost of establishing one hectare	Ratio Ordinal Interval	Means, frequencies, percentages and standard deviation
To assess the influence of livelihood improvement on forest cover in Uasin Gishu county.	-No of bags of maize produced per acre -No of bags of potatoes produced per	Nominal Ratio Ordinal	Means, frequencies, percentages and standard deviation

	acre -No of bags of beans produced per acre -No of farmers who benefit from employment opportunities created -No of farmers who collect fuel wood from forest -Amount of money earned from sale of crops -No of farmers who cut grass/graze in the forest	

Source: Researcher (2015)

3.9 Ethical Considerations

To ensure compliance with ethical consideration the researcher sought permission from the relevant authorities. The respondents were given introductory letter for their permission to participate in the study. The names of the respondents were not disclosed unless on mutual agreement. All confidentialities of the respondents were not disclosed to the third party. The researcher observed honesty and practiced integrity (Shamhoo and Resnik, 2009). The data results, methods and procedures and probabilities were honestly reported by the researcher .Biasness was avoided in data collection, analysis and interpretations. The researcher avoided careless errors and negligence, being critical in examination of findings so as to keep good records of research activities.

CHAPTER FOUR

4.0 DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

Chapter four gives detailed data analysis, presentation and interpretations of the study findings. Data was collected and analyzed through the use of descriptive and inferential statistics. The data was then presented in tables. The discussion of the findings enabled the researcher to make inferences on the influence of PELIS in promoting forest cover. The study findings were then linked to the researcher's opinion in relation to the existing knowledge for close interpretation and discussion. The chapter is organized into sections beginning with presentation of the respondents' background information and the subsequent sections have been organized to follow the research objectives. There were a total of 224 people including 6 forest station managers and 218 CFA members involved in this study through the use of questionnaires and interview schedules.

4.2 Respondents Return Rate

4.2.1 Respondents Return Rate for Forest Managers

All the six forest station managers completed the interview schedules which represented 100% response rate. This response rate was enough to give the researcher confidence to carry on with the study. Table 4.1 shows the distribution of the response return rate amongst the six forest managers.

Table 4.1: Response rate for Forest Managers

Respondents	Sample	Response rate	Percent (%)
Kapsaret	1	1	100
Nabkoi	1	1	100
Cengalo	1	1	100
Kipkurere	1	1	100
Timboroa	1	1	100
Lorenge	1	1	100
Total	**6**	**6**	**100**

All the six interview schedules were returned filled. This very positive response could have been due to the use of purposive sampling technique that ensured all the six forest managers responded to the interview schedule as this was a small sample size. A wealth of experience and knowledge by the forest managers also contributed to the excellent response. The personal administering of the interview schedule by the researcher also significantly influenced the impressive return rate. Brief and precise interview schedules enabled the managers not to fill bored.

4.2.2 Respondents Return Rate for CFA Members

All the 218 CFA members sampled completed the questionnaires which represented 100% response rate. This was significant to allow the researcher to continue with the study. The table below shows the respondents return rate for CFA members..

Table 4. 2: Response Rate for CFA Members

Respondents	Sample	Response rate	Percent (%)
Kapsaret	14	14	100
Nabkoi	55	55	100
Cengalo	60	60	100
Kipkabus	29	29	100
Timboroa	47	47	100
Lorenge	13	13	100
Total	**218**	**218**	**100**

The researcher employed five competent assistants in each forest station who assisted in administering of the questionnaires to the CFA members. This enhanced coverage hence the positive response. The use of brief and precise questionnaires ensured the respondents were not fatigued. The questionnaires were also semi structured hence easier to comprehend and took little CFA members time. This response rate was considered reliable to make conclusions from.

4.3 Demographic Background of Respondents

4.3.1 Forest Managers

4.3.1.1 Level of Education

Given that education is a prerequisite for effective sustainable management of forest resources, the study established the education levels of the forest managers as 3(50%) had diploma as highest education level, 2(33.3%) had undergraduate education and 1(16.7%) had post graduate education. The mean number of years of working experience was 4.4. Table 4.3 indicates the education levels of the forest managers.

Table 4.3: Highest education level

Education level	Frequency	Percent
Diploma	3	50
Undergraduate	2	33.3
Postgraduate	1	16.7
Total	**6**	**100**

Education level and experience are critical tools in sustainable forest management as the manager is able to make sound decisions, interpret and implement policies and regulations that govern forestry practice). It also helps in efficient and effective management of resources both human and material. It is on this strength that the government is encouraging employees to scale up their level of education through gaining of more skills, knowledge and experience by offering study leaves and scholarships.

4.3.1.2 Age Distribution

The table below shows the age distribution of the forest managers. It was observed from the study findings that majority of them are in the age bracket of Over 50 years at 3(50%), 41-45 years 2(33.3%) and 46-50 years 1(16.7%).

Table 4.4: Age Distribution of Forest Managers

Category	Frequency	Percent (%)
18-25 years	0	0
26-30 years	0	0
31-35 years	0	0
36-40 years	0	0
41-45 years	2	33.3
46-50 years	1	16.7
Over 50 years	3	50
Total	**6**	**100**

Nzuve, (2010) observed that one of the key ingredients to an organizations strength and growth is having the right people in the right place at the right time. From the findings it was noted that majority of the forest managers were aging as there was none in the age bracket of 40 years and below. This poses a threat to succession and continuity of the organization. Positively age reflects the experience that one has gained over the years which is significant for increased effective and efficient productivity. There is likelihood of low productivity as the aging employees would tend to focus more on his forthcoming retirement as opposed to concentrating his efforts in working towards the achievement of the organization objectives.

4.4 Demographic Background of Community Forest Association Members.

4.4.1 Gender Distribution

Gender distribution is vital to forest management and conservation as each gender is well suited for specific activities. It was established from the study that 130(59.6%) CFA members were females while 88(40.4%) were males. Table 4.5 below depicts gender distribution for the CFA members.

.Table 4.5: Gender Distribution

Category	Frequency	Percent
Male	88	40.4
Female	130	59.6
Total	**218**	**100**

The study showed that the biggest population of the CFAs are females, who participate in PELIS, culturally the societies expects females to be in the forefront to ensure that food is available to the children and the family at large hence the increased percentage. It is them who spent most of the time with the children as opposed to the males.

4.4.2 Age Distribution

Most forestry activities are labour intensive especially PELIS. This would mean that energetic people take the forefront. It was established that majority of the CFA members were in the age bracket of 36-40 years with 112(51.4%), 41-45 years 30(13.8%), 46-50 years 25(11.5%), over 50 years 21(9.6%), 31-35 years 20(9.2%), 26-30 years 10(4.6%) while there was no representation in age category of 18-25 years. Their mean age (in years) was 38.4 with a range of (min 18, max 72). Table 4.6 shows the age distribution of the CFA members.

Table 4.6: Age Distribution of CFA Members

Category	Frequency	Percent
18- 25 years	0	0
26-30 years	10	4.6
31-35 years	20	9.2
36-40 years	112	51.4
41-45 years	30	13.8
46-50 years	25	11.5
Over 50 years	21	9.6
Total	**218**	**100**

It is evident from the study findings that majority of the farmers are at their prime age hence able to effectively use their energy in food production for their families. It is also important to note that at age 41 years the number of farmers starts to decrease, this could imply subsequent decline in energy and vigour. There is also low representation in ages between 18-35 years, as this could also imply that this youthful age; the youth are engaged in either schooling or other sources of income.

4.5 Plantation Establishment and Forest Cover

4.5.1 Planting backlogs

A huge planting backlog is an indicator of large unstocked plantation areas. There was a total backlog of 6066 hectares as at 2008 while as at 2014 there was 1,935.6 hectares. This represented 18.8% (2008) and 6 %(2014) respectively. The total forested area was 26,141.9 hectares as at 2008 and 30,272.3 hectares as at 2014 as indicated in table 4.7 below illustrates the planting backlogs.

Table 4.7: Planting Backlogs

Year	Total forest Area (Ha)	Forested are a (Ha)	Backlog (Ha)	Percent
As at 2008	32,207.9	26, 141.9	6066	18.8
As at 2014	32,207.9	30,272.3	1,935.6	6

The findings from the study established that planting backlog reduced from 18.8% to 6% as at 2008 and as at 2014 respectively. This represented a decrease of 60% in planting backlog. This development could be attributed to the influence of PELIS as a strategy in increasing forest cover. As the CFA members are allocated plots to cultivate their crops they also assist in planting and weeding tree seedlings alongside accepted agricultural crops.

4.5.2 Area Established through PELIS

The table below covers the area that was established 2008-2014 when PELIS as a strategy was introduced at the forest stations. The study shows that there was a steady increase in area of plantations established using PELIS strategy i.e. 2008(4.3%), 2009 (6.96%) ,2010(11.75%) ,2011(18.46%) 2012(12.78%),2013 (21.18%) and 2014 (24.56%).

Table 4.8: Area Established through PELIS

Year	Area Established (Ha)	Percentage (%)
2008	177.6	4.30
2009	287.4	6.96
2010	485.4	11.75
2011	762.6	18.46
2O12	528	12.78
2O13	874.8	21.18
2014	1014.6	24.56
Total	**4130.4**	**100**

It was noted from the analysis that a total of 4130.4 hectares was established with PELIS from 2008-2014. It is only 2012 (12.78%) which revealed reduced establishment area that could have been due to anticipated general election for 2013, prolonged drought and transfer of forest managers. The planting backlogs stood at 1935.6 hectares as at 2014 that could have been due to continued plantations felling that do not correspond to plantations establishment rate following the lifting of the logging ban in 2012 by the government and lack of approved felling plans as indicated in table 4.2 above. The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation. (O.A. Ndomba *et al.*; 2014). V. K. Agyeman at el., 2003, established that about 78 percent of Ghana current total area of commercial public and private forest plantations

of 35, 000 ha were established using the taungya system.

Hoefsloot *et al*., (2011) observed that although Shamba system existed in the years 2007 and below, it was abused by the implementers and never had stringent rules and regulations to govern it as PELIS does. However, as part of conservation efforts to replenish the forest cover, members of the CFA are supplied with certified seedlings, which they plant in the allocated portions and tend to them during cropping season (R.Manyaka, 2015). The area under PELIS increased from 2933 hectares in 2010/2011 financial year to 9939 hectares in 2012 /2013, according to the statistics by KEFRI (R Manyaka, 2015). The official said the scheme is a driving force in replenishing the forest cover while giving communities an opportunity to enjoy the forest economic benefits (R. Manyaka, 2015). Mr. Mwanzia the project manager (GZDSP) noted that the issue of ownership by community has improved rehabilitation efforts as there are fewer planting backlogs (KFS, 2014).

4.5.3 Major Species Planted

The table below shows the major tree species grown in the state forests. The study findings revealed that the species compositions were: *Cupressus lusitanica* 2,424.5 ha (58.7%), *Pinus patula* 1,086.3 ha (26.3%), *Eucalypts* 375.9 ha (9.1%) and indigenous 243.7 ha (5.9%).

Table: 4.9: Major Species planted

Species	Area established (Ha)	Percentage (%)
Cupressus lusitanica	2,424.5	58.7
Pinus patula	1,086.3	26.3
Eucalypts	375.9	9.1
Indigenous	243.7	5.9
Total	**4130.4**	**100**

The major species grown for industrial plantations and conservation in all the six forest stations included: *Cupressus lusitanica*, *Pinus patula* and *Eucalypts* species, all exotic. On conservation front, the common indigenous species included *Podocarpus falcatus*, *Podocarpus latifolius*, *Juniperus procera*, *Vitex keniensis*, *Olea* spp etc.The indigenous species are planted along catchment areas, degraded sites and for biodiversity conservation.

4.5.4 Rate of Increase in Forest Cover due to PELIS

The total forested area of the six forest stations was 32,207.9 hectares. Given that the total area established with plantations by 2014 was 4130.4 hectares, it therefore means that the percentage increase in forest cover during the PELIS period was 12.8%. Comparatively the percentage increase in forest cover without PELIS was 7.8%, this was from a total area of 2502.4 hectares of plantation established. Table 4.9 below illustrates the rate of increase in forest cover as a result of PELIS.

Table 4.10: Rate of increase of forest cover due to PELIS

Category	Total forest area (ha)	Area planted (ha)	Percent
As at 2008 (NO PELIS)	32,207.9	2,502.4	7.8
As at 2014 (PELIS)	32.207.9	4,130.4	12.8

According to the study findings on table 4.7 on the influence of plantation establishment on forest cover, there was an increase of 12.8% of forest cover following the planting of 4130.4 hectares of planting backlogs as at 2014. This therefore means indeed PELIS significantly contributed to forest cover as CFA members were allocated plots in clear felled areas and other open suitable areas to cultivate their crops; they too assisted in planting tree seedlings in the plots and tended them until canopy closure at about three years. By doing this KFS was able to realize plantation establishment of large areas as indicated by the study findings. As the farmers provided labour freely for land preparation, land cultivation, pitting, planting, weeding and protection. A well managed PELIS can significantly contribute to attainment of 10% forest cover by 2030 as envisaged in the vision 2030 and the constitution. Comparatively, the areas that were established without PELIS were low i.e 2502.4 (7.8%) hectares compared to 4130.4 (12.8%) hectares, area established with PELIS during the same period. This could have been low due to grassland planting that emphasized spot hoeing and spot weeding. There were also subsidy from multinational companies like Timsales, Pan Paper Mills and Raiply as they would provide funds for reforestation programmes of cleafelled areas. However, these have since stopped.

According to (FRA, 2015), the rate at which the world is losing its forests has been halved, but an area of 129 million hectares of South Africa has still been lost since 1990, UNs Food and Agriculture Organization report says. Improvement has been seen around the globe, even in the key tropical rainforests of South America and Africa. "FRA, 2015 shows a

very encouraging tendency towards a r education in the rates of deforestation and carbon emissions from forests and increases in capacity for sustainable forest management", said FAO director general Jose Graziano da Silva. Halting deforestation is a key focus of UN negotiations for a global pact limit disastrous climate change caused by greenhouse gas emissions.

The net annual rate of loss which takes into account the planting of new forests has slowed from 0.18 percent in the 1990s to 0.08 percent over the last five years. Planted forest area has increased by more than 110 million hectares since 1990 and now accounts for seven percent of the world's forest area (FRA, 2015). M Nicholson, 2000 observed that Kenya’s forest cover has tripled over the last 10 years increasing allaying fears of massive environmental degradation. According to government statistics released in March 2012, forest cover had risen from a low of 1.7 percent in 2002 to 5.9 per cent. The forest in both NP and FR which had been seriously degraded is now showing signs of recovery, pole stage trees are beginning to emerge from the climber tangles even where assisted regeneration had not been done earlier. (R Manyaka, 2015).

4.5.5 Plantation Establishment without PELIS

The study findings indicate that a total of 2502.4 hectares was established between 2001-2007 .It can be noted that is relatively low compared to the area that was established through PELIS 2008-2014 which was 4130.4 hectares. The largest area of plantation established was 474.6 hectares representing 18.97% in 2001 while the lowest was in 2002 with 199.8 hectares representing 7.98%. Table 4.10 below shows the plantations establishment without PELIS.

Table 4.11: Area Established without PELIS

Year	**Hectares Established (Ha)**	**Percentages (%)**
2001	474.6	18.97
2002	199.8	7.98
2003	372.6	14.89
2004	455.4	18.20
2005	328.8	13.14
2006	279.0	11.15
2007	392.4	15.68
Total	**2502.4**	**100**

The areas that were established without PELIS were low i.e 2502.4 (7.8%). Lack of funds from the government for reforestation programmes of clear felled areas was inadequate and this could have resulted to low plantation establishment coverage

4.6 Plantations Survival Rates and Forest Cover

4.6.1 Survival Rates of Plantations Established Through PELIS

The table below indicates the survival rates of plantation established through PELIS. From the study findings, the mean survival rate of plantations established with PELIS was highest in 2008(84.7%) and the lowest in 2013 (64.2%) as shown in table 4. 11. The study found that the survival rates of plantations established with PELIS were higher at 84.7% while without PELIS was 50.3%. The mean survival rate for plantations established with PELIS was 75.1%.

Table 4.12: Survival rates of plantations established through PELIS

Year	Area (Ha)	No. Of Seedlings Planted	No. Of Seedlings That Survived	Survival Rate (%)
2008	177.6	284,160	240,684	84.7
2009	287.4	459,840	338,442	73.6
2010	485.4	776,640	597,236	76.9
2011	762.6	1,220,160	920,000	75.4
2012	528	844,800	631,910	74.8
2013	874.8	1,399,680	898,595	64.2
2014	1014.6	1,623,360	1,245,117	76.7
Total	**4130.4**	**6,608,640**	**4,871,984**	**75.1**

The study findings could be attributed to the reduced competition for water and nutrients due to weeding, fertilization and low pruning done by the PELIS farmers. As the farmers weed their plots they too weed the young trees. As they apply fertilizers to their crops young trees too benefit from speel overs to the rooting system of trees. All these activities together with the protection the farmers provide to their crops, the young trees too are protected from straying livestock and wildlife hence increased survival rates.

Trees grown under PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI (Manyaka R, 2015). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012). The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004).

4.6.2 Survival Rates of Plantations Established without PELIS

The table below shows the various plantation survival rates in different years. The highest mean survival rate recorded was 50.3 %(2007) and 50.3 %(2005) while the lowest was 29.6% (2002). On average the survival rate for all plantations established without PELIS was 45.2%, table 4.12 below.

Table 4.13: Survival rates of plantations established without PELIS

Year	Area (HA)	No of Seedlings Planted	No. of Seedlings Survived	Survival rate (%)
2001`	474.6	759,360	325,006	42.8
2002	199.8	319,680	94,625	29.6
2003	372.6	596,160	250,387	42
2004	455.4	728,640	336,632	46.2
2005	328.8	526,080	264,618	50.3
2006	279.0	446,400	223,200	50
2007	392.4	627,840	315,804	50.3
Total	**2502.4**	**4,003,840**	**1,810,272**	**45.2**

These low survival rates could be attributed to competition for water and nutrients faced by tree seedlings. As seedlings are established in grassland through spot hoeing and poor spot weeding is done instead of complete weeding as in the case of PELIS. These tree seedlings also did not benefit from fertilization and protection provided by farmers. Grazing

and browsing by livestock and wild animals on young plantations caused mass death of the saplings hence low survival rates. There was no protection offered by the government as in the case of PELIS where farmers offered protection for both their crops and saplings. (table 13).

4.7: Cost of Plantations Establishment and Forest Cover

The study sought to find out if PELIS contributed to reduction in the cost of plantation establishment. From the study it came out that cost of plantation establishment for both with and without PELIS was 39,527/= and 50564/= per hectare respectively across all the six forest stations under study. This shows what KFS is saving Kshs 11,037 (21.8%) in establishing one hectare of plantation by use of PELIS. Table 4.13 below illustrates the above.

Table 4.14: Costs of plantation establishment

Category	Cost/ha without PELIS (Khs)	Cost/ha by PELIS (Khs)	Difference	Percent
Costs	50,564.00	39,527.00	11,037.00	21.8

The findings of the study established that the government could save up to Kshs 11,037 (21.8%) per hectare by use of PELIS. This money could be channeled to other activities like pruning. Given that farmers carry out array of activities at the preliminary stages of plantation establishment, the cost of establishing one hectare of plantation is reduced. The activities include land preparation, cultivation, pitting and planting. As PELIS farmers provide labour by carrying out the activities for free as they prepare land for their crops, the government saves a lot of money that would otherwise have been used to pay casuals.

According to FD, 2005, the cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. It was also established that multinational companies like Rai Ply, Tim Sales and Comply who are major consumers of forest raw materials insignificantly participate in reforestation of areas they have clear felled hence contribute to

continuous increase in planting backlogs. These companies should substantially compliment government efforts in reforestation in terms of raising seedlings and provision of funds for labour engagement during plantations establishment. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

4.8 Livelihood Improvement and Forest Cover

4.8.1 Main source of Livelihood

The illustration in table 4.14 is on the main sources of livelihood for the CFA farmers. They largely participate in PELIS to enhance their livelihood through diversification of sources of livelihood in form of more adequate income, increased wellbeing, and improved food security among others. It was established from the study that majority of the CFA members 210(96.3%) reported their main source of livelihood was farming -PELIS. Only 2.7% and 0.9% indicated business and employment respectively as sources of livelihood.

Table 4.15: Main source of livelihood

Category	Frequency	Percent
Farming-PELIS	210	96.4
Employment	2	0.9
Business	6	2.7
Total	**218**	**100**

The study showed that PELIS significantly contributed to food security for the forest adjacent communities as shown on table 4.14. The study findings established that 210 (96.3%) of the CFA members source of livelihood was farming-PELIS. Food security has been a challenge to our society especially the vulnerable segment. It is therefore notable that PELIS provided excellent opportunity to the poor as they are able to improve their livelihood by cultivating their crops in the forest alongside trees. By doing so they are able to secure

food for subsistence consumption and are able to sale the surplus for income so as to get other necessities of life like, clothes, shelter, food, education etc. The farmers too are able to graze their animals in the forest hence improved animal production for meat and milk and even sale for income. They are also able to get firewood and secure employment opportunities hence improved livelihood. Fresh water catchment and soil preservation are important inputs to agriculture and food production

Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

4.8.2 Shamba Ownership in the Forest

As illustrated in table 4.15 below, it was observed from the study that majority of the CFA members 214(98.2%) owned a shamba in the forest as shown in table 4.15 below. The average size of shamba owned by each former was one acre.

Among them 4(1.8%) that do not own a shamba, the reasons given were that two had not yet been allocated, one has no time to manage the farm while the other has his own farm.

Table 4.16: Shamba Ownership in the Forest

Category	Frequency	Percent
Owns forest land	214	98.2
Do not own forest land	4	1.8

The findings indicate that majority 214 (98.2%) of the farmers own plots in the forest. This could show that the main source of livelihood of the farmers was farming and also the shambas back at home were inadequate for both subsistence and commercial food production. For the farmer who does not own a plot in the forest, this could imply that the

farmer does only grazing or cut and carry grass in the forest but does land cultivation at home. The one that has not been given one is probably still new in the CFA membership and shambas are exhausted hence has to wait until the shambas are available i.e. until clear fell is done. For the 214 members that owned a shamba, the median (IQR) number of acres was 1 (0.5, 2). Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small (Prince Osei *et al*.2008).

Although PELIS was established to promote forest plantation development through enhanced forest establishment and survival of plantation trees, it has also provided other significant benefits such as making available arable land for landless and contributing to food security (Paul O Odwori at el., 2013).

4.8.3 Crop Harvest per Acre

The table below shows crop production per acre by the CFA members. On average, the PELIS farmers harvest 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre as shown in table 4.16.

Table 4.17: Crop harvest per acre

Category	Bags/acre	Max	Min
Maize	22	40	1
Potatoes	54	150	1
Beans	5	60	0.5

This means the farmers were able to get food from crop diversification and can dispose of the surplus to meet other family needs. It is on the basis of these crops that the farmers derive their livelihood from and the main driving force behind going for the government land.

4.8.4 Crops Grown Alongside Trees

From the study findings, the table below shows the response of CFA farmers if they grow their agricultural crops alongside trees. Majority of the members 202(92.5%) grew either crops alongside tree seedlings while only 16(7.5%) did not.

Table.4.18: Response of farmers on crops grown alongside tree

Response	Frequency	Percent
Yes	202	92.5
No	16	7.5

This means that PELIS ensured plantation establishment .However for the 16(7.5%) it could imply that their plots were in their first year of cultivation hence not ready for tree seedlings planting (table 4.17). The farmers are allowed to cultivate food crops which are planted between the trees on the same lands (Evans, 1992).

4.8.5 Types of Crops Grown.

As indicated in table 4.18 below, there are three main crops grown by CFA farmers in the scheme. Hundred and sixty nine (77.6%) grew maize, 109(50%) potatoes while 95(43.5%) grew beans. The potatoes are grown around the highland plateau of the county.

Table 4.19: Type of crops grown

Crop	Frequency	Percent
Maize	169	77.6
Potatoes	109	50.0
Beans	95	43.5

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The study showed that the stable food was maize which has the highest percentage; the second was potatoes and lastly beans. All these were grown for subsistence use and any surplus was sold for income to enable the families acquire other necessities. Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars (R Manyaka, 2015).

4.9 Other Benefits from PELIS

A part from securing food from PELIS, the farmers also immensely gets other benefits that ultimately enhance their livelihood socially, economically and culturally. These included; fuel wood 214 (98.2), grazing 196 (89.9%), source of income 183 (83.9%) and 155 (71.1%) as shown on table 4.19.

Table 4.20: Other Benefits from PELIS

Benefit	Frequency	Percent
Employment	155	71.1
Firewood	214	98.2
Grazing	196	89.9
Source of income	183	83.9

The study observed that besides PELIS providing food security as the main benefit there were other benefits that came along with it to the PELIS farmers. These included; source of fuel wood for majority of the CFA members 214(98.2%). The second most important other benefit it provided was grounds for livestock grazing 196(89.9%) many members of the adjacent communities were also able to get income 183(83.9%) from the sale of the PELIS crops besides provision of employment opportunities too 155(71.1%). All these other benefits were geared towards enhancing the forest adjacent communities' livelihood (table 4.19).

4.10 Perception of PELIS as Plantation Establishment Strategy by Forest Managers.

The table below shows the perception of PELIS by forest managers. All the six forest station managers applauded PELIS as the most appropriate method of plantation establishment 6 (100%). This was due to reasons outlined on table 4.20.

Table 4.21: Take on PELIS by Forest Managers

Comparison	Frequency	Percent
It enhances water absorption and retention for plant use	6	100
It reduces weeds, therefore less competition for nutrients hence increased plantation survival rate	6	100
It keeps away animals which may browse seedlings unlike grassland which is prone to animals and percolation of water is less	6	100
It reduces establishment costs and damage by pests and rodents	6	100
It significantly contributes to backlog reduction hence increased forest cover	6	100
It contributes to food security for the forest adjacent communities	6	100

Two most common methods of plantation establishment are grassland and PELIS. The former, involved establishment of plantations on grassland, without total cultivation but hoeing of planting spots, while the latter involves total cultivation of the area plantation is to be established. From the study all the forest station managers 6(100%) observed that the strategy was positive in that it enhanced plantation hygiene hence less competition for water and nutrients by trees. PELIS strategy also ensured that animals which may browse on young seedlings are kept away. It also helped to reduce the plantation establishment costs as the cost of land preparation and planting are borne by the farmers. Damages caused by pests and diseases were reduced, plantation hygiene ensured trees were not attacked by the pests and diseases. As farmers tended their crops and did fertilization, thus trees also benefited from fertilizers hence faster growth (table 4.20).

4.11 Challenges Encountered by Forest Managers during the PELIS Implementation.

Table 4.21 below depicts the challenges encountered by forest station managers during the implementation of PELIS. The study established the following as the most common challenges; interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba

6(100%). There was also late shamba preparation by farmers 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers 4(66.7%), uprooting of saplings 3(50%), need for close supervision 6(100%) during planting and after and lack of transportation means 3(50%).

Table 4.22: Challenges encountered by forest managers during the PELIS period

Challenges	Frequency	Percentage
Interference of seedlings rooting system during cultivation	5	83.3
Periodical straying of livestock/wild animals in the shambas	6	100
Late shamba preparation hence delayed time of planting	4	66.7
Over pruning of trees by those doing PELIS	4	66.7
Use of agrochemicals	6	100
Transportation of seedlings during planting	3	50
Uprooting of the saplings purportedly to create space for further cultivation	3	50
Supervision of farmers to avoid damage to the planted seedlings	6	100

The study found out that the most common challenges faced by the forest managers during the scheme implementation was interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba hence browsing or trampling on young tree seedlings 6(100%). There was also late shamba preparation by farmers which affected planting time 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers also affect the growth of the trees, uprooting and deliberate disturbance of the rooting system of the young seedling by the PELIS farmers 4(66.7%).This was to enable the farmers to continue cultivating their shambas for a long period. This affected the growth of young trees hence reduced the survival rate.

It was also established that PELIS require close supervision 6(100%) during planting and after to avoid damage to the planted tree seedlings by the PELIS farmers. Lack of transportation means 3(50%), for the seedlings during planting was also observed by the forest station managers as a hindrance to effective planting exercise. Abandonment of one

year established plantations by the PELIS farmers created room for trees competition with weeds for water and nutrients and grazing and browsing by both domestic and wild animals (table 4.13).

V. K . Agyemen, 2003, observed that in traditional taungya system there were many challenges that included, increased incidences of sabotage to tree seedlings by farmers, the farmers had more interest in their agricultural crops than the forest trees and there were many incidences of forest land encroachment. Farmers deliberately killed planted seedlings to extend their tenure over portion of land , since a successful plantation meant the discontinuation of cultivation on allocated plots, girdling of stems, cutting trees above and below ground, debarking and over pruning. Other challenges were; Cleared more land for plantation development than needed for the available seedlings. Failed to weed around tree seedlings , whereby retarding their growth so as to extend land use rights beyond three years. Illegally farmed other areas in forest reserve, degraded or not , which were not allocated for taungya.

Planted food crops that were not compatible with the tree crops leading to reduced tree growth, lack of supervision by forestry officers. Inadequate financing mechanisms, abuse of powers by public officials especially in farm allocation (Agyeman *et al*., 2003), over pruning of trees, inappropriate use of agrochemicals and encroachments of forest land for farming.

4.12: Challenges Encountered by Farmers during PELIS Implementation

Table 4.22 below brings out the challenges encountered by farmers during PELIS implementation. The findings of the study were; destruction of crops by wild animals 212(97.2%), livestock destruction 201(92.2%), pests and diseases 189(86.7%) and climate change 153(70.2%).

Table 4.23: Challenges Encountered by Farmers during PELIS period

Challenge	Frequency	Percent
Livestock destruction	201	92.2
Destruction of crops by wild animals like monkeys	212	97.2
Pests and diseases	189	86.7
Climate change	153	70.2

The PELIS farmers cited destruction of crops by straying livestock 201(92.2%), wild animals 212(97.2%) graze and browse on crops, infection and attack by pests and diseases on crops 189(86.7%)i.e. maize lethal necrosis disease and maize stalk borer were mentioned as a threat to crops production by farmers. Effects of climate change 153(70.2%) as it happened in 2014 posed a challenge to the farmers as the rainfall was inadequate and erratic. All these could result to great loses by farmers in both crops and livestock production.

Following wanton destruction of Mau forest there is significant change in rainfall patterns and temperatures .Rainfall seasons sets in late for a shorter period compared to previously with prolonged dry spells, temperatures are relatively high hence high rate of everpotranspiration and dehydration on vegetations and animals besides drying up of water bodies. This makes PELIS activities very challenging especially tree establishment (table 4.14). Farmers also indicated that they are being exploited by KFS as they don't get a share from the sale of the various forest products given that the Forest Act 2005 recognizes the CFA as key stakeholders in forest management.

4.13 Other factors influencing forest cover

On forest governance, if there are no proper rules, regulations, policies and code of conducts and ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, floods and prolonged dry spell. High poverty levels will drive the community to go into the forest to draw their livelihood. This will eventually lead to forest destruction and degradation hence forest cover loss and consequently loss of forest related benefits that would otherwise been assured if there was sustainable utilization of forest related resources.

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five reviews the whole study findings summary, conclusions and recommendations based on the study objectives. The study title was the influence of PELIS on forest cover- a case of Uasin Gishu County, Kenya. The study objectives were: to establish the influence of plantation establishment on forest cover, to evaluate the influence of plantations survival rate on forest cover, to determine the influence of cost of plantations establishment on forest cover and finally to assess the influence of livelihood improvement on forest cover.

5.2 Summary of the Study Findings

The study findings were summarized as below:

5.3. Influence of Plantation Establishment on Forest Cover

On the influence of plantation establishment on forest cover, a total of 4130.4 hectares was established with PELIS from 2008-2014. This represented 12.8% forest cover increase of the total planting backlog of 4438 hectares as at 2008 while that without PELIS was 8.4% increase. The study findings showed there was steady increase in plantation established using PELIS while that one without was relatively low. As the farmers were given plots to grow their crops, they too were expected to provide labour for land preparation, pitting, planting and protection of the planted trees.

5.4 Influence of Plantations Survival Rates on Forest Cover

In respect to plantations survival rate on forest cover, the average survival rate of plantations established with PELIS according to the study was (75.1%). The mean survival rate of plantations established without PELIS was 45.2%. The findings showed that as the farmers tended to their crops in form of weeding, fertilization and protection, trees too benefited from the same. Competition for water and nutrients was minimized through complete weeding.

5.5 Influence of Cost of Plantations Establishment on forest Cover

On the influence of plantation establishment costs on forest cover, the study established that plantation establishment with PELIS costs Kshs 39,527 and without PELIS Kshs 50,564. This translates to Kshs 11037 (27.9%) saving for the government. Land preparation, cultivation, planting, weeding and protection are very expensive exercises. And

all these are subsidized by PELIS farmers. Hence the savings can be redirected to other essential activities like plantations pruning.

5.6 Influence of Livelihood Improvement on Forest Cover

With regard to influence of livelihood improvement on forest cover, the study findings showed that the majority of the CFA members 210(96.3%) indicated that their main source of livelihood was farming-PELIS, only 6(2.7%) and 2(0.9%) indicated business and employment respectively. On average the farmers harvested 22 bags, 54 bags and 5 bags of maize, potatoes and beans per acre respectively. The findings also indicated that 169(77.6%) of the PELIS farmers grew maize, 109 (50%) potatoes while 95 (43.5%) grew beans. Many families were able to earn a living from PELIS especially food, fuel wood, employment and grazing

5.7 Conclusions of the Study

Total cultivation for plantation establishment is expensive but gives the largest established plantations area, the highest survival and growth rates. In the absence or inadequate funding or new technologies PELIS remain a viable option for plantations establishment. PELIS benefits both KFS and farmers, though mechanisms to ensure more benefits to farmers should be explored. PELIS plays a very vital role in forestry management as it is a component of participatory forest management which brings on board other key stakeholders like the forest adjacent community in sustainable management of forest resources. There was a significant increase of 12.8% forest cover of the plantations established through PELIS which was 4130.4 hectares from 4438 hectares as at 2008, hence increased forest cover. A well managed PELIS that observes the laid down guidelines can go a long way in contributing towards attainment of a 10% forest cover as a country by the year 2030 as envisaged in vision 2030 and the constitution.

The study established that the mean survival rates for plantations established with PELIS were higher compared to plantations established without PELIS i.e. at 75.1% and 45.2% respectively. This could have been due to reduced competition for water and nutrients as the PELIS farmers weeds both the young trees and their crops besides fertilization that trees benefit too from. As the farmers protect their crops from straying livestock and wild animals trees too benefits.

The cost of plantation establishment with PELIS (Khs 39,527) was reduced by

Kshs.11037 as compared to plantation established without PELIS (Khs 50,564).This reduction translates to 27.9% savings for the government. This could have been possible due to array of activities farmers carry out for free like clearing, cultivation, pitting, planting, weeding and finally protection. However, the government subsidizes the labour costs.

The study also revealed that 210(96.3%) reported that farming -PELIS is their main source of livelihood. On average the PELIS farmers harvested 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre, With 169 (77.6%) growing maize, 109(50.0%) potatoes while 95 (43.5%) grew beans. It can also be deduced that PELIS targeted the poor in the society and the majority grew maize as it is a stable food crop in Kenya.

5.8 Recommendations

The researcher recommends that:

1. Forest adjacent communities should be given incentives or other sources of income like establishment of nature based enterprises e.g apiculture, ecotourism, acquaforestry e.t.c in forest reserves so that they can devote portion of their land for tree planting hence attainment of 10 percent forest cover as internationally recommended.
2. There should be very close supervision of all PELIS activities carried out by the farmers to ensure minimal damage to the established plantations. PELIS guidelines should be adhered to and implemented to the latter (Appendix vii). The Forest Act no. 7 of 2005 provisions on governance should too be enforced. This would enhance plantations survival rates.
3. Multinational companies like Rai Ply, Tim Sales, and Comply among others should be made to supplement government efforts in terms of contributing some funds for hiring labour for plantation establishment programme as they are the major consumers of forest raw materials. This can go a long way in lowering the cost of plantations establishment.

4. There is need for the government (KFS) to fast track the Forest Management and Conservation Bill of 2014 that has a clause on cost-benefit sharing between KFS and the CFAs as the latter feel they are short changed on forest products benefits especially the share from the sale of timber that eventually would enhance their livelihood.

5.9 Suggestions for further Research

The researcher suggests the following areas for further studies:

1. The influence of PELIS on the plantation rotation age.
2. Cost benefits sharing among key stakeholders.
3. Study on increasing spacing in plantation establishment.

5.10 Contribution to the Body of Knowledge

It was observed from the literature reviewed that there was insignificant relation to the influence of PELIS notably; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement to forest cover in Kenya and globally. The literature reviewed failed to show empirical evidence on how PELIS influences forest cover. It is therefore vital to note that this study has brought out the contribution of the scheme towards attainment of the recommended international thresh hold of 10% forest cover of a country's total land area.

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APPENDICES

APPENDIX 1: TRANSMITAL LETTER FOR CFA MEMBERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu County. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly fill in the questionnaire and thank you in advance.

Yours faithfully,

Tobias Achungo.
L50/71180/2014

APPENDIX II: QUESTIONNAIRE FOR CFA MEMBERS

SECTION A: Demographic information (tick where applicable)

1. What is your gender? (a) Male (b) Female

2. How old are you? (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45 (e) 46-50 (f) Over 50 years

SECTION B: Livelihood Improvement and Forest Cover

1. What is the main source of your livelihood?

   (a) Farming- PELIS (b) Employment (c) Business

2. Do you own a shamba in the government forest?

   (a) Yes (b) No

   If no, why?..

3. If yes, How many acres?...

4. What do you grow? (a) Maize (b) Potatoes (c) Beans

5. How much yield do you harvest per acre?

   (a) Maize……….. (b) Potatoes……….. (c) Beans…...

6. Do you grow your crops alongside tree seedlings? (a) Yes (b) No

7. What other benefits do you get from PELIS?...

8. What major challenges do you encounter during PELIS period?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………

APPENDIX III: TRANSMITAL LETTER FOR FOREST MANAGERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu county. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly respond to the interview schedule and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX IV: INTERVIEW SCHEDULE FOR FOREST STATION MANAGERS

SECTION A Demographic Information (tick where applicable)

1. How old are you?

   (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45

   (e) 46-50 (f) Over 50 years

2. What is your highest education level?

   (a) Diploma (b) Undergraduate (c) Postgraduate

3. What is your work experience at this station?......................................

SECTION B: Livelihood Improvement and forest cover

1. Do you have a CFA? (a) Yes (b) No
2. How do they participate in PELIS?...

SECTION C: Plantation establishment and forest cover

1What is the total forest area of your station? ……………………………………….

3. What was your planting backlog as at 2008?...
4. What was your planting backlog as at 2014?..
5. How many hectares were established each year with PELIS between 2008-2014 ?.........
6. How many hectares were established each year without PELIS between 2001-2007?.....

SECTION D: Plantations survival rate and forest cover

1.What were the survival rates of the plantations established with PELIS between 2008 and 2014?

(i) 2008……. (ii) 2009……. (iii) 2010…… (iv)2011…..

(v) 2012….. (vi) 2013………….. (vii) 2014…………..

2. What were the survival rates of plantations established without PELIS between 2002-2007?

   (i) 2002…… (ii) 2003… (iii)2004…… (iv)2005…

   (v) 2006…… (vi) 2007……..

SECTION E: Cost of plantation establishment and forest cover

1 What is the cost of establishing one hectare with PELIS?..

2 What is the cost of establishing one hectare without PELIS?.......................................

SECTION F: PELIS Perception and Challenges

1. What is your take on PELIS and Grassland as main methods of increasing forest cover?……………………………………………………………………………………
………………………………………………………………………………………………
2. What are the major challenges you face while implementing PELIS……………………

APPENDIX V: WORK PLAN

ACTIVITY	DURATION
Topic selection	March, 2015
Proposal development	March, 2015
1st correction of research project proposal	March, 2015
1st defense of research project proposal	April, 2015
Research project proposal correction	April, 2015
Pilot-testing of research instruments	April, 2015
Data collection	May, 2015
Data analysis	May, 2015
Preparation of 1st draft of research project report	June, 2015
2nd correction of the project report	June, 2015
Final defense of the research project report	July, 2015
Final correction of research project report	July, 2015
Final submission of the research project report	July, 2015

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APPPENDIX VI: RESEARCH BUDGET

ITEM	COST (KIHS)
Typing and printing	
• Proposal	10,500
• Project	18,000
Transport	10,000
Data analysis services	5,000
Internet/library services	8,000
Miscellaneous	6000
Grand total	**57,500/=**

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APPENDIX VII: RULES AND REGULATIONS FOR IMPLEMENTING PELIS

Section 47(2) h of the Forests Act 2005 stipulates that ‘’a community forest association (CFA) authorized by the director to participate in the management and conservation of a forest or part of such a forest shall have a right to carry out plantation establishment through non-resident cultivation ‘’ among other activities.

The objective of these rules and regulations is to regulate the implementation of the PELIS scheme in forest reserves.

1. Compliance with the Forest Act.

(a). The permit holder must comply with the provisions of the forests Act 2005 and any rules made there under .Should be permit holder or his/her agents or employees commit any breach of the Forest Act or of any rules made there under, he/she will have committed an offence and will render the permit liable to cancellation or any other penalty imposed by the director in accordance with the forest act 2005.

2. Eligibility for cultivation

(a).All cultivators must be residents of areas adjacent to the forest stations and be members of a registered community forest association.

3. Demarcration of plots

a) Forest zonation and mapping will be done to identify the forest areas suitable for cultivation.
b) The individual plots will be demarcated by the area divisional forest officers, be numbered and put on a sketch map.
c) The sketch maps shall be displayed on the station notice boards.
d) A site –specific management plans will be complied for each forest station implementing PELIS.

4. Allocation method

a) Implementation will be through CFA management committees, consisting of representatives of cultivators.
b) A ballot system will be used in all cases during allocation of plots.
c) All participating CFAs must sign an agreement form before cultivation commences
d) All selected cultivators must obtain a permit before cultivation commences.

5. Crops to be crown

a). Only maize, beans (non-climbers), potatoes, carrots, peas, onions Dania, Chilles, amaranths and cabbages shall be planted in PELIS scheme. The service may review the crops to be grown from time to time.

6. Cultivator’s obligations

a) The CFA leadership will ensure that none of its members or ants will take any action that will be harmful to the survival of the plated trees.
b) The cultivator shall ensure that he/she and or/his agents will not take any action that will be harmful to the survival of the planted stock. If the survival is low they will participate in either beating up or replanting, whichever is appropriate.
c) Any form of interference with the normal growth of seedlings and trees is prohibited.
d) The CFA, its agents or employees shall give assistance whenever called upon by the service in controlling illegal activities and in preventing or fighting forest fires.
e) No permit holder will be allowed to lease out or sell the allocated plot. Any attempt to lease or sell a plot will lead to the plot being reposed and plot will revert back to the service.

7. Commencement of tree planting and cultivation period

a) Planting of tree seedlings shall be done after one crop season (one year)
b) Cultivation period shall not exceed three years after tree planting. After this period, a permit holder shall vacate his/her plot.
c) Kenya Forest Service will not be obliged to allocate another plot at the expiry of 3 years period.

8. Areas restricted for cultivation

a) Cultivation shall not be allowed within the water catchment areas and slopes exceeding 30%
b) Cultivation shall not be allowed within a minimum of 30 meters on either side of river valleys and wetlands.
c) Cultivation shall not be allowed in firebreaks, roads reserves and natural forest and under plantations over 3 year old.

d) Under no circumstances shall cultivation be re-opened in plantations after expiry of the authorized 3-year period.

9. Tools and equipment for land preparation and use of fire

   Hand tools will be sued for land preparation but animals drawn equipment may be used for the initial opening up. Use of tractors and combine harvesters is prohibited.

   Use of fire in land preparation is prohibited .If the use of fire is absolutely necessary; the divisional forest officer shall give written authority, after inspection of the area.

10. Payment of shamba rent

    All cultivators will pay prevailing annual rental fees for the allocated plot before cultivation commences for that particular year.

11. Erection of temporary structures

    No residential structures will be allowed in PELIS scheme areas except in areas with high incidences of game damage. Construction of such structures shall be erected under a written permit from the director who may also issue guidelines on the number of such structures in a forest area.

12. Penalty of abuse of the system

    Any cultivator who flouts these conditions will:

    a) Lose the right to cultivate in the forest
    b) Be liable to prosecution as specified in the forest act
    c) Be liable to both (a) and (b) above
    d) Loose any crop that may be on the plot to the service

13. Areas to be opened up for cultivation

    a) The opening up of any new areas should be commensurate with the planting programme.
    b) Any opening shall only be authorized by the divisional forest officer after inspection of the area and consent from the director of KFS
    c) Plot demarcation shall be done under the supervision of the divisional forest officer.
    d) The plot sizes shall a maximum of one acre and a minimum of ½ acre.

14. Documents to be maintained

    Each station shall maintain a shamba register indicating locality, sub-

compartment number, name of cultivator, national identity card number, and receipt number, date of payment and size of plot.

A sketch map of the area under cultivation shall always be maintained, updated and be prominently displayed in the forester's office.

A register of all temporary structures shall be maintained where applicable.

15. The divisional forest officer will be held responsible for any abuse of the system.

NB: The field stations will receive all the 15 conditions but the farmer should be given the first 14 conditions translated into Kiswahili .The 14 conditions will be prominently displayed in the station notice boards.

APPENDIX VIII: DRAFT PELIS CULTIVATION PERMIT

The PELIS cultivation permit is granted to Mr./Mrs./Miss/Ms……………………….
ID NO………………………… Member of …………………………………………………. Community Forest Association of P.O BOX …………………………………………to cultivate plot number……………………………….measuring ………………..hectares for purposes of identification marked in red and numbered accordingly on the sketch plan on this permit in Sub-Compartment Number………………………………….in ……………………….Forest Station for a period of one(1)year, subject to the following terms and conditions.

1. This permit only allows the permit holder to use plot .This permit does not make the permit –holder owner of the plot. The permit -holder has no right to sell, rent, or act as owner of plot in any way.

2. The permit-holder shall plant only annual crops on the plot. The service has a list of approved crops. The permit –holder shall choose his crops from this list and plant only annual crops.
3. The permit-holder shall help the service upon request in
   a. Beating up or replanting, whichever may be appropriate, in cases of low survival of tree seedlings.
   b. Controlling illegal forest activities
   c. Preventing or fighting forest fires and
   d. Any other activity for the benefit of the forest.
4. The permit –holder shall use hand tools to work the plot but animal drawn equipment may be used for the initial opening only.
5. The permit-holder shall not build any structure on the plot, except with written permission of the service.
6. Breaking the terms of this permit is an offence and if that happens, the service may withdraw this permit. A permit-holder who breaks the terms of this permit may be liable to other disciplinary measures.
7. The permit –holder accepts the risk of injury, harm or death from trees, logs, wild animals, game, rivers and streams, and other hazards on the plot and neighboring forest. Whether the injury happens to property, the permit-holder, or another person, the service is not responsible.

8. This permit does not give the permit holder exclusive possession of the plot or any part thereof and does not create not is it intended to create a lease or tenancy in any way whatsoever.

Signed by the Permit holder……………………Counter signed by CFA official……………

Date ………………………   Date……………………………

Name of issuing Officer………………………………………………………………………

Official Stamp …………………………………………….Date………………………

APPENDIX IX: RESEARCH AUTHORIZATION LETTER

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/0581/6469**

Date:
9th November, 2015

Tobias Otieno Achungo
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of plantation establishment and livelihood improvement scheme on forest cover a case study of Uasin Gishu County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Uasin Gishu County** for a period ending **17th July, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Uasin Gishu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Uasin Gishu County.

The County Director of Education
Uasin Gishu County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX X: RESEARCH CLEARANCE PERMIT

THIS IS TO CERTIFY THAT:
MR. TOBIAS OTIENO ACHUNGO
of UNIVERSITY OF NAIROBI, 41-30100
eldoret,has been permitted to conduct
research in *Uasin-Gishu* *County*

on the topic: ***INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER A CASE STUDY OF UASIN GISHU COUNTY KENYA***

for the period ending:
17th July,2016

Permit No : NACOSTI/P/15/0581/6469
Date Of Issue : 9th November,2015
Fee Recieved :Ksh 1,000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 7122

CONDITIONS: see back page

INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER: A CASE OF UASIN GISHU COUNTY, KENYA

BY

TOBIAS OTIENO ACHUNGO

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT

UNIVERSITY OF NAIROBI

2015

DECLARATION

This research project report is my original work and has not been presented for a degree in any other university.

Sign________________ Date ________________

TOBIAS OTIENO ACHUNGO

L50/71180/2014

This research project report has been submitted for affirmation with my approval as university supervisor.

Sign____________________ Date________________

KORINGÚRA JULIUS

Lecturer Department of Extra Mural Studies

School of Continuing and Distance Education

University of Nairobi

DEDICATION

This research project report is dedicated to my family for their unwavering support, prayers a nd patience during the entire preparation period.

ACKNOWLEDGEMENT

I wish to register my sincere appreciation to my supervisor Koring'ura Julius for finding time out of his busy schedule to guide me through the preparation of this research project report. It is with humility that I register my gratitude to my lecturers; Dr Paul Odundo, Dr Anne Assey, Mr. Sakaja, Mr.Patrick Cheben, Mr. Ochieng Owuor and Mr Peter Lukhuyani, for taking me through the various courses that were relevant to this study. I would also wish to thank my employer, Kenya Forest Service for granting me an opportunity through a course approval to sharpen my skills, knowledge and experience to enhance my performance. I also recognize the immense support from fellow students during the course and project write up. I salute the University of Nairobi for providing an enabling environment to help me reach this far. My heartfelt gratitude also goes to my family once more for their patience, support and prayers during the study. And finally I thank Mss Gladys for taking her time to do typesetting and formatting this research project report.

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LIST OF ABBREVIATIONS

AFCN	African Forest Conference Network
CFA	Community Forest Association
FAO	Food and Agriculture Organization
FC	Forestry Commission
FD	Forest Department
FRA	Forest Resource Assessment
FR	Forest Reserve.
FRIN	Forestry Research Institute of Nigeria
FSD	Forest Services Division
IGA	Income Generating Activities.
KFS	Kenya Forest Service
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MFW	Ministry of Forestry and Wildlife
MMMB	Miti Mingi Maisha Bora
MTS	Modified Taungya System
NACFA	National Alliance for Community Forest Association
NEMA	National Environment and Management Authority
NP	National Park.
PELIS	Plantation Establishment and Livelihood Improvement Scheme
PFM	Participatory Forest management
REDD+	Reduction in Emissions from Deforestation and Degradation
REMA	Rwanda Environmental and Management Authority
UNEP	United Nations Environmental Programme
WB	World Bank

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ABSTRACT

There has been increasing rate of forest destruction and consequently decline in forest resources in Kenya due to the high rate of increase in human population, thus exerting pressure on natural resources. The decline has been attributed to factors such as deforestation, commercial agriculture, urbanization, pastoralism, charcoal production, forest cultivation, illegal logging, forest fires and replacement of indigenous forests with exotic plantations. Decline in forest resource has been further exacerbated by increasing poverty levels and the community perspective of forest as public good in addition to changing global forest trends. It is on this back drop in forest cover levels that the government of Kenya through Kenya Forest Service modified "shamba system" to PELIS which for a long time has been used by the government of Kenya to raise forest plantations where the forest adjustment communities benefits from cultivation of crops in the forest and KFS benefits from forest plantation establishment at low costs. The key objectives were; to establish the influence of plantation establishment on forest cover, to determine the influence of plantation survival rate on forest cover, to investigate the influence of cost of plantation establishment on forest cover and to assess the influence of livelihood improvement on forest cover. Therefore this study aimed at establishing the influence of PELIS as a strategy to increase forest cover. The study was informed by the theories of Environmental Kuznets Curve and forest transition, which affirms that a U shaped relationship exists between environmental quality and economic development and also contends that forest cover, is an indicator of environmental quality and income levels. Survey research design was used. The study targeted a population of 6521 including 6 forest station managers and 6515 CFA members. Stratified, purposive and simple random sampling methods were used to select forest stations and CFA members for the study. Structured questionnaires, interview schedules and personal observations were used to collect primary data besides use of secondary data from the offices. Descriptive statistics such as means, tables, percentages and frequencies were used. The findings of the study provided an insight on the contribution of PELIS in increasing forest cover. The study established that PELIS contributed to 12.8 % increase of forest cover. The results clearly showed that the survival rates were higher in plantations established with PELIS than those established without PELIS by an average of 75.1% and 45.2% respectively. On the cost of plantation establishment, it was established that the cost was Khs 39,527 with PELIS while without PELIS was Kshs 50,564 representing 27.9% savings. The study also confirmed that there was livelihood improvement as PELIS farmers harvested an average of 22 bags, 54 bags and 5 bags of maize, potatoes and beans respectively. The study also established that 96.3% of CFA members dependent on farming-PELIS as a source of livelihood. It was recommended that there is need to give forest adjacent communities alternative sources of livelihood as incentives so that they could allocate a portion of their land for tree growing, there should also be closer supervision of all PELIS activities to reduce damage to young plantations. Multinational companies should supplement government efforts through provision of funds for reforestation and government should fast track forest management and conservation bill that provides for benefit sharing.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The world's forest, cover some 3500 million hectares, of which 57% of these are located in developing countries mostly in the tropics, worldwide about 1.6 billion people rely heavily on forest resources for their livelihood and estimated 400 million are directly depended on forest resources. Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. It is estimated that the rate of global forest loss has hit 13 million hectares per annum in the last decade (2000-2010) (FAO, 2010). The world looses 7.3 million hectares of forests a year, about four times the size of all gazetted forests in Kenya. Due to extensive reforestation, this new forest shrinkage has slowed slightly from the 8.9 million hectares lost in the 1990s. Despite the decrease, deforestation has not declined significantly since 2000 (KFS, 2014). Globally tropical forests are being reduced at the rate of about 7.5million hectares of closed forest and 3.8million hectares of open forest annually (Lenely, 1982). The global net rate of change in forest cover for normal tropics is estimated to be 23% (Arched *et al*, 2002) signifying a high reduction rate of forest covers.

Closer home, Africa has lost 64 million hectares of forest between 1995 and 2005, the greates decline on any continent during the same period. Fuel wood gathering drives much of the forest depletion. Timber exports also play a role, with 80% of the Congo basin's timber production being exported, mainly to China and European Union. Much of the world's wood is harvested illegally. Illegal logging accounts for more than half of timber production in Russia, Brazil and Cameroon. In addition to devastating forest ecosystems, illegal logging robs forest dwellers of their livelihoods, fuels social turmoil, and deprives timber producing countries of up to ksh. 1.14 Trillion of revenue annually (KFS, 2014).

In the case of Africa, even though most tropical African countries had considerable forest cover at the beginning of the 20th century that ensured environmental stability, the need to increase food production, high demand for wood products and rapid increase in infrastructural development to satisfy growing population has resulted in rapid increase in deforestation and forest degradation (Forestry Commission, 2011). KFS, 2014 observed that forest cover loss leads to; increased occurrence of floods, reduced recharge of ground water, decreased water volume in rivers during dry seasons, sometimes rivers dry up, increased drought periods from an average 2 year cycle to 4 year cycle, increased sediment loads in

rivers, lakes and oceans, changing rainfall patterns, soil desiccation, inadequate timber and fuel wood, loss of bio diversity and intrinsic value of forests amongst others. All these are as a result of climate change.

FAO (2010) observes that, over the last century for example, forest cover in the African region has been under intense pressure from human activities in the name of livelihood sustainability and development. This perhaps explains why Africa now has the second highest rate of deforestation worldwide with 3.4 million hectares of forest loss per annum. Thus the need to seek remedial measures through community, national and global initiatives such as Reducing Emissions through Deforestation and forest Degradation (REDD+) has been well received by many policy makers and governments towards environmental sustainability and green development, as enshrined in the goal seven of the Millennium Development Goals (Karsenty *et al*., 2012). However, the expense of forest areas is declining across the globe partly as a result of logging activities and also due to conversion of habitat to crop land, agricultural expansion accounts for up to 43% of tropical forest losses (MEA, 2005).

This has led to the recognition of the need to include the communities living close to forests through CFAs in management of forest resources to reduce this rate of forest loss. Only 32.5million hectares of African forest and woodlands or 5% of the total forest area are formally protected. The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in western, central and eastern Africa where there in considerable forest cover (UNEP, 2005).

Africa and South America distinguish themselves by showing distinct decline in forest cover. For Africa the direction for the past twenty years is clear even though the rate of deforestation seem to have declined over the last few years. However, forest cover alone does not tell us what kind of forests we have , what benefits they might provide, how well they are managed or if they are degenerated (FAO, 2010). In the Lake Victoria basin problems among other things such as soil erosion and declining soil fertility have been attributed to loss of forest cover (World Agroforestry Centre, 2006). The land was formerly rich in natural forests but this resource has been severely over exploited. Deforestation combined with unsustainable agricultural methods has resulted in widespread, increasingly conspicuous land degradation (Maitima *et al*., 2010). As a result of the above, there is need to stop further deforestation through conventional strategy to save biodiversity for the survival of human

kind.

According to MMA (2008), Africa has high per capita forest cover of 0.8 hectares per person compared to 0.6 hectares globally. On average forests account for 6% of GDP in Africa which is the highest in the world. In Uganda for example forests and woodlands are now recognized as an important component of the nations stock of economic assets and contribute in excess of US $54.6 million to the economy through forestry, tourism, agriculture and energy. The state of Rwanda's forests and woodlands and their importance to the national economy is also well documented. Forests are designated as protected areas which host game parks and forest resources and make contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. They also make an indirect contribution to sustainable agriculture and are sources of medicine, fodder, honey, essential oils as well as handcrafts and construction materials. However, they are also threatened by mining, fires and poaching (REMA, 2009).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. FAO, 2013 noted that there has been a straight line decrease in forest cover in Kenya between 1990 and 2012 ie 1990 37,080km^2, 2000 35,820km^2 and 2012 34,450 km^2. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

Muthike (2004) notes that forests plays a vital role in water catchment protection, climate change mitigation, agricultural production, hydroelectric power generation, habitat for wildlife, ecotourism, food, employment, income, research and education among others. In addition over 1 million households, living within a radius of five kilometers from the forest reserves depends on the forests for cultivation, grazing, fishing, food, fuel wood, honey, herbal medicine, construction materials, water and other benefits (KFS, 2012). Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

Despite all these importance, the forests are under tremendous pressure from growing population and therefore innovative strategies are required to support their sustainable management (KFS, 2012). Forest cover in Kenya has been decreasing over the years and the main drivers have been poor legislative frame work and governance, politics, encroachment, illegal cultivation, illegal logging, charcoal burning, excision, poverty, population pressure, industrialization and poor understanding of the benefits of forests by the local communities.

World Bank (2007) observes that sawn timber remains highly valued and in short supply in Kenya for a number of reasons. One is that the land available for forest is diminishing in medium to high potential again ecological zones. Forests in such places face direct competition from land for agriculture, infrastructure and urban development estimated at 5,000 excerbarated by an increasing population on limited available land is dramatically reducing forest acreage. The enactment of the Forest Act 2005 as admittedly helped to revitalize the section by giving local communities a stake in the management of state and county forests.

As in many countries, Kenya official status do not accurately reflect the extend of forest resources as a contributing factor to the economy. These gaps fuel the perception that forests meet substitutes needs only and is therefore not important. Data for the period 1989-2005 indicate little change in forest cover yet known existence suggest the figure for gazetted forests should be lower. Conversely extensive tree planting which took place under the afforestation and extension scheme on private land and state forests and in some forests managed by local authorities should show higher forest cover in these areas. It is therefore recommended that a participatory approach to formulating and implementing forest policies is adopted in order to ensure local communities support (KFS, 2014).

1.2 The Concept of Taungya System

1.2.1 Taungya System in Thailand

In Thailand, a country that neighbours Burma, the destruction of forest through shifting cultivation was a serious problem. More than 10,000 hectares of forest lands were denuded annually by hill tribes and other farmers . Forest village scheme was introduced by the government and Forestry Organization as an attempt to stop further spread of shifting cultivation and deforestation. The forest village system offered hill tribesmen and others who practiced slash and burn agriculture considerable inducements to settle down. One of principle aims of the scheme was to keep a steady labour force on

hand for long term needs of forestry, while at same time providing rural families with income and other benefits from the kind of farming they choose to practice (S A O Chamshama *et al.,*1992).

The underlying principle of the scheme was to link reforestation with social welfare of the people involved. A systematic programme of public information and the involvement of community leaders were necessary to gain public acceptance of forest villagers before they could be started in the FVS, the families were allowed to grow crops during the first three years of establishment. The families were also provided with free agricultural advice, primary education and medical services. Families who agreed to give up shifting cultivation for settled land use were given tenure of a plot of land to construct a house and develop a home garden, where crops could be grown and few animals reared. In return the farmers were required to help establish and maintain forest plantations. (S A O Chamshama *et al*.,1992).

Although the scheme rain well below targets, opportunities had been provided for people to settle, with long term employment prospects and affording a higher standards of living than previously. The families had abandoned shifting cultivation thus reducing pressure on native forests. Also, through forest villages biodiversity had been improved. Not with standing numerous weaknesses and constraints of the scheme were identified, which included setting up of villages with promised facilities required significant expenditure, there was scarcity of capable managers to oversee the village functions, where forest was still plentiful, ensuring adherence to forest village policy was difficult, and so illegal shifting cultivation continued ; some sites were on steep slopes with poor soil, thus cultivating crops was hard and yields were low, cash flow problems arose as payment as payment of bonus were not made until the end of the first year of participation. Furthermore, financial incentives were too low for some ,resulting in their leaving to seek work elsewhere (S A O Chamshama *et al*.,1992).

1.2.2 Taungya System in Uganda

In Uganda, taungya has been practiced for many years. Uganda admits taungya to be a good practice of carried out properly like it was done in Burma. By planting trees with food crops weed invasion was prevented and soil cover was retained and through taungya there was a maximum use of land as both crops and trees were grown. Also employment was provided over a large scale.(tree growers and crop growers are all

employed) and there was cheaper forest establishment and protection and whose legummous crops were grown, the nitrogen benefited the trees, yet and certainly most important, taungya system promoted food security. However, over the past 30 years or so, the results of taungya have been disastrous in terms of establishment of tree plantations. Farmers faced with possibility of becoming landless, once the trees are fully established often damaged or killed the trees (S A O Chamshama *et al.*,1992).

In some parts of Uganda , farmers severely pruned the trees branches to prevent them from shading their crops, whereby extending the period they can use the land for their crops. In some instances, farmers physically uprooted the trees (or partially uprooted to severe some of the roots) to further extend the period they can grow their crops, some instances of heaping weeds on top of saplings had also been recorded. Furthermore, the farmers planted unacceptable crops such as planting tall crops, like maize and sorghum, which soon overtopped the trees so weakening and killing them, several crops species are known to be controversial and are excluded in forest plantations in some countries, such crops include bananas and plantains. (Musa spp), Cassavas (*Manihot utilissima*) and sugar cane *Sacharum officinarum*). Sugar cane for example, is generally extended because it is a long growing crop, so it is feared to deplete the soil and because it casts a heavy shade, Also it is known that allelepathic effects exists in which sugar cane suppresses the growth of trees seedlings (S A O Chamshama *et al.*,1992).

Most Taungya problems in Uganda were reported to have been caused by luck of adequate supervision. To redress the situation and to ensure equitable access to forest resources, the government of Uganda formulated policies and laws to ensure that communities, especially vulnerable ones participated in decisions that affect their livelihoods. One such policy was that of collaborative forest management (CFM). CFM is an approach that enhances community participation and development of partnerships for Forest management. In areas where CFM is implemented that is better enforcement of forest rules (D .A. Ndomba *et al.*, 2014)

1.2.3 Taungya System in Ghana

In Ghana about 75 percent of her forest plantations were established using taungya system in the earliest version of taungya that was launched in Ghana in 1930, the farmers had no rights to benefits accruing from the planted trees. Also, the farmers had no decision making role in any aspect of forest management. A s as a result , the farmers

tended to neglect the tree crops since they would not directly benefit when it matured. The farmers also realized that if the tree canopy closed, they would be asked to stop farming to enable the establishment of the tree crop from which they would not benefit. Consequently, most farmers deliberately killed the trees so that they would not be asked to stop farming. Other evils committed by the farmers included clearing more land for plantation development than was needed for available seedlings. They failed to weed around the seedlings , there by retarding their growth so as to extend land use rights beyond three years; the farmers also illegally farmed other areas of the forest reserved whether degraded or not (S A O Chamshama *et al*.,1992).

Furthermore, the farmers planted food crops most were not compatible with the tree crops leading to reduced tree growth. Other problems included lack of supervision by the forestry department; inadequate financing mechanisms and abuse of power by public officials, especially in farm allocations. As a result, the system was suspended in 1984. Following these observation the taungya system in Ghana was revised in 2002 to make itself financing and sustainable and partly to provide employment and alleviate poverty in the rural communities. (S A O Chamshama *at el*.,1992). In the new version, the farmers became owners of forest plantation products while (FC) and forest adjacent communities were shareholders. The farmers provided labour, did pruning and maintenance and tending of forest plantings; the Forest Commission provided technical expertise, farmers training, provision of equipment and tools , stock inventory and marketing of forest products; the land owners contributed land while the forest adjacent communities provided the services of protecting the investment from fire.

The consultation process devised an equitable benefits sharing frame work based on Contribution of the participants. These levels of contribution together with stakeholder expectations led to the following benefits sharing framework; The farmers get 40% of Timber benefits; the forest communities gets 40% , the land owners get 15% while Forest adjacent communities get 5% of the benefits accruing from the Modified Taungya System (MTS). This was to ensure sustainable system and continuous flow of benefits to participating farmers after harvest of food crops at the end of third year and there should be some bulk payment at the time of harvesting logs. (O. A Ndomba *et al*., 2014)

1.2.4 Taungya System in Kenya

In Kenya, Taungya system was adopted in 1910 and was referred to as shamba

System. First introduced as a modified form of the taungya used in south East Asia; the shamba system was a method, of forest plantation established in which farmers tend tree saplings on state owned forest land in return for being permitted to intercrop food crops until canopy closure. The shamba system significantly reduced the cost of forest establishment as weeding costs were borne by the farmers. The system also provided significant benefits to farmers in the form of food.

In 1990s the shamba system was often abused and young trees were often neglected or deliberately cut to enable cultivation to continue beyond the usual three years period. These actions slowed down reforestation progress and resulted in vast areas of land under cultivation within forest reserves. Following these mishaps the system was banned by presidential decree in 1987, and in the following year all forest residents were evicted from forest areas. The shamba system was subsequently replaced by

A modified system referred to as Non- Residential Cultivation (NRC). In the NRC, farmers were Integrated into the Forest Department (FD) as resident workers. Under NRC the farmers were allocated plots , still by the name ,shambas' but with guaranteed work for nine months per year. The produce from the shambas was considered part of workers emolument as they tended the young trees. This NRC too was banned after a few years and was being replaced with a redesigned system referred to as the Plantations Establishment and Livelihood Improvement Scheme (PELIS). The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation (O.A. Ndomba *et al.;* 2014).

1.2.5 Justification for Plantation Establishment and Livelihood Improvement Scheme (PELIS)

PELIS involves farmers planting and tending the saplings on a state owned forests in r eturn for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years). Before being allowed to cultivate in the forest they sign a PELIS cultivation permit where they commit themselves to abide by the rules and regulations that govern the scheme (Appendix vii). The scheme is meant to improve the economic gains of participating farmers while ensuring success for planted tree (AFCD, 2012).

In mid 2007, acting in conformity with the Forest Act 2005, the Kenya Forest Service (KFS) in collaboration with key sector partners particularly forest adjacent communities revis ited the pros and cons of Non –Residential Cultivation (NRC). KFS outlined a new model, re-branded as the Plantation Establishment and Livelihood Improvement (PELIS).

The overall objective of PELIS was to establish forest plantations and improve the livelihoods of communities through sustainable collaborative management of gazette forests. The PELIS initiative was to have the following other objectives.

1) To reduce the cost of plantation establishment that currently stands at Kshs.25.000 per hectare at three years using the pitting and spot weeding method as compared to about Kshs.10,000 per hectares under shamba system (by 2007).
2) To improve the rate of growth of the planted stock as would be the case under complete cultivation as compared to pitting and spot weeding method.
3) To allow the people leaving next to forest reserves improve their food security and incomes through raising of crops together with trees in forest reserves and hence change their attitudes to forest conservation.
4) To reduce and eventually eliminate replanting backlogs that currently stands at 16,000 hectares.
5) To minimize the need to seek assistance in plantation establishment from forest based industrial companies.
6) To minimize the need for KFS to hire labour for plantation establishment.
7) To achieve sustainability in harvesting and replanting of plantations. (KFS, 2007)

1.3 Statement of the Problem

Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. Forest underpin important sectors of the economy including agriculture, tourism, energy, water and manufacturing among others. Further 80% of the population depends on wood as the primary source of energy.

Kenyans population is on the rise and stood at 38.6milion in 2008 and at the 2.9% growth rate. The resulting high demand for forest and woodland products by arising population created led to conflicts and environmental degradation as forest are cleared to make way for human settlement and agriculture, industrialization, frequent drought in Narok,

for instance are attributed to the rapid growth of settlement and the increased rate of deforestation by conversion of burning and illegal logging upstream in the Mau forest.

It was on this background of the myriad products and services that forests provide to human kind and other flora and fauna. Hence it was important to check on the growing negative effects of climate change that is aggravated by the continued deforestation with the key driver being human induced activities. PELIS as strategy is capable to reverse the trend if well managed and the rules and regulations governing the scheme are observed to the latter.

1.4 Purpose of the study

The purpose of the study was to establish the influence of Plantation Establishment and Livelihood Improvement Scheme (PELIS) on forest cover.

1.4.0 Research Objectives

1.4.1 Objectives of the Study

1. To establish the influence of plantation establishment on forest cover.

2. To determine the influence of plantation survival rate on forest cover.

3. To investigate the influence of cost of plantation establishment on forest cover.

4. To assess the influence of livelihood improvement on forest cover.

1.5 Research Questions

1. How does plantation establishment influence forest cover?

2. How do plantation survival rates influence forest cover?

3. How does the cost of plantation establishment influence forest cover?

4. How does livelihood improvement influence forest cover?

1.6 Significance of the Study

The continued degradation of forests resources calls for concerted efforts by the policy makers and researchers to slow or stop the loss of forest cover. The findings of the study will help the policy makers in the industry to know the level of success or failures of PELIS and make the necessary adjustments if need be. The researcher will be able to fill the

knowledge gap in terms of the role of PELIS in increasing forest cover. The government will also be able to appreciate the role of PELIS in terms of bridging the gap on food insecurity.

KFS as a key player will be able to determine whether it is working towards achievement of 10% forest cover as envisaged in the constitution and the internationally recommended thresh hold. The study will also influence level of participation of donors in the sector by having confidence and continue funding if the forest cover level increases. Positive results will gear the country towards economic development by improving the key sectors of the economy like industries, agriculture, energy and tourism that largely depend on sustainable management of forest resources.

1.7 Basic Assumptions

The study assumed that all the six forest stations under the study are practicing PELIS and by extension have Community Forest Associations (CFAs). The planting backlogs have substantially been reduced. The researcher assumed that the respondents will cooperate and give honest response to the questions in research tools. It was also assumed that the sample size chosen was adequate to enable the researcher draw valid conclusions on the study.

1.8 Limitations of the Study

In the course of the study it was difficult to obtain the updated information on the plantation records. The CFAs also provided varied information on food production through PELIS, this was overcome through verification of secondary data with field data, interviews and personal observations. Weather, difficult terrain and vast areas of some forest estates also posed some challenges during data collection in the field this was lessened by visiting the field early in the day and putting on the right attire. Language barrier was also a challenge and was minimized through an interpreter. The study used structured questionnaires, secondary data and interview schedule as data collection tools besides personal observations.

1.9 Delimitations of the study

The study covered the six forest stations in Uasin Gishu County. As anything more than this could not be viable given the time limit and resources available especially funds. Given that NRC was modified to PELIS in 2007 and its implementation started in 2008 in selected stations in the country. The study covered plantations established 2001-2014.

1.10 Definition of Terms

Plantation Establishment and Livelihood Improvement Scheme	PELIS involves farmers planting and tending the saplings on a state owned forests in return for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years) (AFCD, 2012).
Plantation Establishment	It encompasses species selection, site clearing, staking out, pitting and planting of the tree seedlings in the field.
Forest cover	It is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production system (for example in fruit plantations and agro forestry systems) and trees in urban parks and gardens (FAO, WB, 2015) It is an area more than 1 ha in extent and having tree canopy density of 10% and above.
Livelihood	It is a means of making a living. It encompasses people's capabilities, assets (including both material and social resources), income and activities required to secure the necessities of life.
Livelihood improvement	This is when livelihood is sustainable and it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conways,1991).
Planting Backlog	These are un stocked areas that were either clear felled or opened up for PELIS but have not been planted.
Survival Rate	It is the percentage of saplings surviving after six months of establishment in their natural environment.
Sapling	A young tree, especially one not over 10cm in diameter at breast height.
Acquaforestry	It is the science of raising acquatic animals and trees.
Apiculture	It is the management and study of honey bees.
Taungya	It is a Burmas word meaning hill cultivation; it was introduced

in India in 1 890. It is a modified form of shifting cultivation in which labour is permitted to raise crop in an area but only side by side with the forest species planted by them.The practice consist of land preparation, tree planting, growing agricultural crops for 1 – 3 years until shade becomes dense and then moving on to repeat the cycle in different areas

1.11 Organization of the Study

Chapter one represents background of the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study. It also entailed delimitations of the study and definition of terms as used in the study. Chapter two covers review of related literature on plantations establishment, plantations survival rate, costs of plantations establishment and livelihood improvement on forest cover. Theoretical and conceptual frameworks and gaps in literature review were also highlighted.

Chapter three described research methodology, which included research design, target population, sample size and sampling techniques, research instruments, pilot testing and data collection procedures, data analysis and ethical considerations. Chapter four gives detailed analysis, presentation, interpretations and discussions of the study findings while chapter five reviews the whole study summary, conclusions and recommendations based on the study findings.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The chapter looks at both theoretical and empirical literature related to plantations establishment and livelihood improvement scheme (PELIS) and its influence on forest cover. The chapter also reviews the independent variables in relation to the dependent variable. It also identifies knowledge gaps that are as a result of analyzing the theoretical and empirical literature.

2.2 The Concept of Forest Cover

Deforestation in all of the Kenyans five water towers is mainly due to poor environmental governance. This consequently include loss of forests cover, increased soil erosion, drying or rivers and stream, siltation in dams and increased cost of forest related products such as timber (NEMA, 2005). Forest and woodlands are particularly vulnerable to climate change. This is because the impact of climate change and variability led to change in land cover and land use, increased incidences of pests, diseases and fire outbreaks and foment loss of livelihoods (Ogwang *et al*, 2010). Apart from offering oxygen, fuel and building materials, trees store important quantities of carbon , which if released, contribute to global warming (FRA, 2015). Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water resources which loses its quality as forests condition worsens (MEA, 2005).

Over 80% of Kenyans rely on wood biomass for their energy requirements, which exerts considerable pressure on the tree and forest resources. In addition, the wood conversion technologies for timber manufacturing and charcoal production are obsolete and wasteful leading to overharvesting of trees to meet the demand. Globally and nationally the climate is changing, and this is having a direct impact on forest resources and ecosystems and on people and their livelihoods flooding, landslides and drought. Forestry can play an important role in both mitigation and adaptation to climate change, and towards green growth. Forest plantations supply industrial wood and also play a crucial role in conserving biodiversity, providing habitat for wildlife, conserving soils and regulating soils and regulating water supplies and sequestering carbon dioxide, they also reduce pressure on the indigenous forests (Forest policy, 2015).

Of late weather patterns have changed in the county especially rainy seasons comes late, the rains are erratic, prolonged and intense droughts coupled with drying up of rivers and springs. The price of forest products have also been ballooning due to acute scarcity. It is therefore on this background that the study explored the influence of PELIS in increasing forest cover in state forest areas to mitigate on the above mentioned challenges. Demand for sawn timber, furniture, timber packaging and less end use is increasing as building construction is expanding and standard of building is improving. Consumption in 2010 is estimated at 855,000m3 consisting of Kenya production of 760,000m3 and imports of 95,000m3, (MMMB, 2013).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

MFW,2013 observed that forests in Kenya including plantations are important in conservation of biological diversity, regulation of water supplies; carbon dioxide sequestering and are major habitats for wildlife which promotes tourism. Forest conserves water catchment areas. They also provide water to support irrigation schemes that are important for agricultural sector development (ICFW, 2013). M Nichlon, 2000 observed the role of native forest as to restore ecosystem services like water quality, water provision, air quality, soil quality, soil conservation among others. Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

2.3 Policy and Legislation to Improve Forest Cover

Kenya's forest cover is disappearing at an alarming rate. According to sessional paper No.1 of 2007 on forest policy; our forest cover was less than 2% of the total land area as opposed to internationally recommended standards of at least 10%. Lack of adequate

budgetary allocation by the treasury and staff shortage made it necessary to involve the community in a forestation exercise. The PELIS strategy was expected to deliver benefits of increasing the forest cover by involving the forest adjacent communities who were directly affected by both positive and negative activities in the forest.

The forestry sector has been characterized by ineffective regulatory mechanisms and inadequate law enforcement. The Forest Act no. 7 of 2005 that became effective in 2007 was a milestone in forest governance and brought about Community Forest Association participation in plantation establishment through non resident cultivation and protection of the forest resource (Forest Act no. 7 of 2005). Further the promulgation of the of the constitution brought new requirements for natural resource management such as public participation, equity in benefit sharing, devolution and the need to achieve 10% forest cover among others (Constitution of Kenya 2010; Vision 2030, 2008). These challenges are compounded by dwindling public land, which need incentives and clear methods of engagement to encourage investments in commercial forestry on private land. The policy statement is to promote private sector participation in establishment and management of plantations through appropriate forest management arrangements and incentives and promote species diversification through planting of indigenous and exotic species with proven potentials (Forest policy, 2015).

Over the last few decades, policy makers have advocated and applied forestry decentralization as an appropriate means of environment protection and sustainability. (Anderson, 2006).This has often been done with the motivation to increase the involvement of forest based communities and local institutions in forest resource management. Their assumption is that the local people's involvement in forest resource governance is the most appropriate means of ensuring sustainable forest resource management and green development (Robert and Larson, 2005, Ribot and Oyoro, 2006). In pursuit of its commitment to reverse the degradation of forest for examples, the government of Ghana, in 1996, launched the forestry and wildlife master plan to reverse deforestation between 1996 and 2020 which is estimated at 65,000 ha per annum (Forestry Commission, 2001).

Against this background, the forestry sector in Ghana has implemented a number of decentralized schemes (Marfo, 2004). One of them for which the issue of livelihood development and forest reclamation are so crucial is the modified Taungya system (MTS). In 2001 the government Ghana launched the MTS as a decentralized mechanism to halt and reverse degradation of forest resources as well as build community resilience for enhanced

rural livelihoods and poverty reduction. The MTS is a decentralized forest management strategy in which communities are given portions of degraded forest reserve to inter-plant food crops with trees and further nurture trees into maturity under an agreement in which costs and benefits sharing are specified .In this arrangement the forestry commission of Ghana transfers responsibilities to selected forest fringe community members and established local authorities as partners both in managing and drawing benefit from forest reserve to ensure local communities commitment to sustainable forest governance. After over a decade of the MTS, implementation its viability to achieve or deliver livelihood security, forest resource recovery and poverty reduction at the local arena require monitoring and verification (Prince Osei *et al.*,2008).

The Modified Taungya System (MTS) involves the establishment of plantations by the government (FC) in partnership with farmers. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The farmers are allowed to cultivate food crops which are planted between the trees on the same lands. As the farmers does all the labour while not getting paid for it. They will have a share in the future timber revenue. They are entitled to 40%, whereas the government also gets 40% and the land owner and community will obtain 15% and 5% respectively. Many farmers in the MTS are migrant farmers; they go back after 2 years. So the plantations are abandoned, which is not good for the trees as they need to be maintained. It is better for the plantations that the stay for a longer time. The original Taungya system was modified and extended with the benefit sharing scheme because the scheme was boycotted by the farmers due to lack of benefits and voice (Interview Zonal plantation managers of the FC, 2010). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

In recognition of the important role that increased forest cover and food security plays coupled with the challenge of inadequate funding towards forest plantation establishment. The government of Kenya through (KFS) modified "shamba" system which for a long time has been used to raise forest plantations where the forest adjacent communities through

(CFA) benefit from cultivation of food crops in the forest during the early stages of forest plantations establishment of forest plantation at a low cost (Mwatika *et al.*, 2013). Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced as a policy guideline to address the decreasing trend of forest cover. The scheme has been used to establish forest plantations since 2007.

A review of the past studies on the shamba system shows that success and failures depends on how well government guidelines are implemented and enforced when the system was reorganised in 2000, success rates climbed and again recede after the 2003 ban. Funds allocated to the FD for forest operations are grossly inadequate declining from kshs 390 million in 1996 to 95 million in 2004. Though planting has increased, fewer seedlings are surviving, rates have declined from as high as 90% to as low as 10% in some stations (Kagombe *et al.,* 2005).

Since 1968, the country has experienced a major decrease in forest cover which has resulted in reduced water levels, bio diversity, supply of forest products and habitats for wildlife. Also according to sessional paper No 1 of 2007 on forestry policy, the forest sector has been faced with conflicts between forest managers and forest adjacent communities over access to forest resources. In response to increasing back logs and adequate resource capacity within the forest department to reestablish plantations, the shamba system was reorganized and reintroduced in a few districts as NRC in 1994.

2.4 Plantations Establishment and Forest Cover.

Nair (1985) indicates that, in case of severe deforestation, programmes are important to restore the tree cover. When plantations are established, they can provide a sustainable tree cover, but working at the biodiversity and environmental services compared natural forests, the plantations are poor in supplying them. Forest plantations have more potential to grow food crops, as the space between the trees can be used to grow food crops during the first years of plantation establishment. This could be beneficial for people who live and work in forest plantations. So plantation establishment development can be seen as part of agriculture, more specifically as specific type of agro forestry, namely an agrosylvicultural system.

Various options exist for plantations establishment for higher growth and survival rates. Total cultivation though expensive is the most appropriate .In the absence of more resources, NRC is the most viable method. A well-managed NRC has a similar effect to total cultivation ,costs are shared by the community and the forest department and both benefit

(Kagombe *et al., 2005*).without viable alternatives in sight the government should review the ban on NRC in areas where it has been working and establish mechanism to make it work in areas where it has failed .Further to that the FD must recognize the importance of community participation in forest management and in particular the role of the NRC management committees (Kagombe *et al.,* 2005). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

The Kenya forestry sector is today characterized by the problem that the rate of forest estate clear fell does not match the rate of replanting. This results in a rise to backlogs in plantation establishment. For example, of the 170,000 hectares of government owned forest plantations, 20,000 (12 %) hectares are open land or where recently felled and not replanted. Backlogs in forest plantation establishment refer to delayed operations in tree establishment and tending. By 1995 there were a total of 17657 hectares of planting backlogs, 1338 hectares of thinning backlogs, 22,750 hectares of pruning backlogs and 2175 hectares of coppice reduction backlogs (Wanyiri report, 1995). The Ol bolossat forest had over 1000 hectares of forest planting backlogs due to unsustainable tree harvesting and poor plantation establishment but the CFA through PELIS has reduced the backlog to less than 300 hectares (KFS, 2011). Most of the natural forest suffered degradation but now the communities are carrying out rehabilitation of degraded catchment areas.

The aim of KFS plantation programme is to have a sustainable production of forest products that will satisfy the present and future demand. This can only be ensured by timely replanting of harvested plantation areas. In recognition of the need to increase the forest cover in Kenya, the government through sessional paper no.1 of 2007 on forest policy provides guidelines for intensified tree planting inside and outside gazetted forests. Availability of high quality tree seed is key to realization of this policy. Seed quality is assured through KEFRI who is mandated to provide certified, site appropriate, high quality tree seeds in sufficient quantities to meet the national demand. KEFRI endeavors to best practices throughout seed production chain to ensure provision of high quality seeds (KEFRI, 2011). CFAs helped in tree operations and raised some 10.5 million tree seedlings during 2011/2012 compared to 5.8 million seedlings raised by KFS alone per year (KEFRI, 2011).

When the presidential ban came into force in 1999, the planting backlogs stood at 46,000 hectares but replanting efforts have since reduced it to 15000 ha. From 2002 to date

20,000 hectares of industrial forests plantation have been established through PELIS in gazetted forests all over Kenya. During the financial year 2011/2012 KFS had 16, 281 hectares of forests plantation under PELIS. The higher survival rate from 20% to 80% was due to better care for tree seedlings by PELIS farmers and improved forest governance by KFS. Improved tree cover has contributed towards achieving vision 2030's target of 10% forest cover which currently stand at 6.9% of the total land area.

KFS (2007) confirms that, the established young trees are from certified seeds, grows at high rate, fixing an average of 2.7 m3 carbon per hectare from one to age four. This leads to clean environment and reduction of global warming as stipulated in the Millennium Development Goals (MDGs, 2001). Shamba system (PELIS) is allowed under the Forest Act 2005 and is recognized as one way of raising plantations. One way to ensure that people benefit from forest is to allow system such as this, which benefit both the government and farmers.

Those plantation established under monoculture regime interfere with the forest biodiversity, and reducing its water catchment qualities. Farmers have been told to keep off indigenous forests. The noble peace prize laureate Prof. Wangari Maathai contends that "We cannot sacrifice indigenous forest at the expense of exotic plantations". Plantations represent a monoculture of trees, but a forest on ecology system. Maathai affirmed ‘' we are destroying local diversity and greatly the capacity of the forest to be effective water reservoirs (Paulo M, 2010). Forest scarcity induces higher prices of forest products, which encourage both better forest management and the establishment of woodlots and plantations. (Rudel *et al*., 2005) refer to this as the forest scarcity path, which forms the other main route towards forest transition. The success story of Machakos in Kenya provide an example (Tiffen *et al*., 1994)

On the Kenyan side, where piloting a livelihood plantations are being piloted under the PELIS, the system is dominated by maize rather than trees, with respect to quality, the tree will grossly under perform in terms of yield o timber of transmission poles, which people hope to sell at the end. Generally the PELIS approach as it is being implemented now will yield limited benefits in terms of improving forest cover and forestry products and services,

2. 5 Plantations Survival Rate and Forest Cover.

According to Kagombe *et al*., (2005) to attain an increased forest cover, the survival of the planted tree seedlings must be guaranteed. And this is possible through PELIS. As the farmers tend their crops by removing weeds and adding fertilizers the saplings too benefit as

they are not subjected to competition for nutrients with weeds and also they get nutrients from fertilization hence increased survival rate. Given that hygiene of the seedlings is secured through PELIS, higher survival rates for seedlings and lower susceptibility to pests and diseases.

The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004). It is paramount that to achieve a sustained forest cover from PELIS, then law enforcement efforts must be doubled. This will ensure that illegal activities that degrade the forest i.e. deforestation are controlled. The programme PELIS is improving tree cover in gazetted forest areas since it helps to improve survival rate and establishment of forest stands (M Nichlon, 2000). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012).

The reason for committing forest offences are often because of ignorance of the law and negligence They also include poverty, unemployment and the collections of medicinal plants for commercial purposes. Widespread bribery of forest guards and local police, lack of support to junior officers, shortage of vehicles and other equipment in the field to collect evidence of infractions and inadequate fines or sentencing continue to hinder enforcement efforts (World Bank, 2007 a) and create conflict between the authorities and communities in many natural forests.

Although the command and control approach of the past emphasizes law enforcement rather than crime prevention, low enforcement rather crime preventions, KFS understands that it must integrate compliance measures with greater efforts to involve communities in forest management which includes PELIS (Geller *et al.*, 2007). As the farmers tend their crops they also protect the young and the old trees from illegal poaching and destruction. The hygiene they keep in the PELIS areas also help in keeping off pests, diseases and also reduce incidences of fire outbreak. It is recognized that the current trend in forestry management is to move towards participation of communities in management of forest resources. It is difficult to police forests especially in areas where high population surrounds it. The communities are therefore involved in conservation and protection.

The way forward for shamba system is to consider it as a form of joint forest management where the communities will get shamba and in return participate in forest protection, adequate funding of forest protection, KFS enforcement and CFAs in terms of remuneration and housing facilities (KFW, 2013). At this rate of reward it is clear that maintenance of the plots in the second year and third year will be carried out by Taungya farmers. Given that they themselves hire labour for some activities; it is reasonable to assume that they might do the work if the reward matched the market rate. An alternative method of payment would be on a per seedling, survival basis, pro rata. (M K Mc Call and M M Skutsch, 1993).

On the whole the per seedling method is more likely to give satisfactory results, although there will be cases of hardship due to drought and difficulties especially if farmers have land of unequal quality. (M K Mc Call and M M Skutsch, 1993) Growth of the planted areas under shamba system has been reported to be higher than unattended tree plantations (Pudden, 1953, Konuche and Kimondi, 1990). This is contrary to the earlier view, which claimed that growing trees under Taungya reduce the growth (FAO, 1967b)

In Ngare forest station, Nyeri, the forester noted that CFA participation was saving the government a lot of money due to reduced cost of seedling production, tree planting and tree protection. He indicated that a plot of 100 hectares of planting backlog, 70,000 seedlings were needed and these would have cost KFS about 1.4 million. However, KFS was only compensating the community with Kshs 300,000, hence saving Kshs 1.1 million (Kagombe, 1998).

The farmers who have been part of community Forest Associations have been very helpful in managing and protection of the forest “when we plant trees in the forest the farmers have played a key role in the forest positively in line with the Forest Act 2005 which mandates that we work hand in hand with communities’ said Mr. Chege. He added that KFS and the farmers have been collaborating and encouraging the PELIS scheme which enables farmers to plant crops in forest area for three years as they tend seedling, this arrangement has been very beneficial and has ensured 100 percent survival of the planted tree seedlings (KFS, 2014).

Mr. J. Mwanzia, the project manager (GZDSP) expressed satisfaction by the efforts of the community through protection of forest particularly against forest fires. “As we were starting out, there were perennial forest fires as is common with forest during dry seasons and during those times communities offered us little and sometimes no help at all, but since

engaging them directly we have experienced total change of attitude as the communities are first to spot fire and put it off even before involving the forester “said Mwanzia (KFS, 2014). When farmers dig out the mature potatoes, they are cautious not to hurt any of the seedlings. They are growing the produce in state land within, the forest gazetted zone (R. Manyaka, 2015). We play a great role in conserving the environment around the area. And that is why when we plant the tree seedling, we work so hard to ensure they survive” she noted. (R.Manyaka, 2015). Trees grown under the PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI, (R.Manyaka, 2015).

2.6 Cost of Plantations Establishment and Forest Cover.

One of the key objectives of PELIS was to reduce the cost of plantation establishment that currently stand at Kshs 54,500 per hectare at three years using the pitting and spot weeding method as compared to about Kshs 30,350 per hectare under 'shamba' system (KFS, 2007). KFS will benefit from this scheme by saving money that would otherwise be used for land preparation and subsequent maintenance of the planted areas which will be utilized in other conservation programmes. (Chamashama, *et al.* 1992) observed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial income to the peasant farmers and reduction of forest plantation establishment costs.

Enabor (1979) observed that, introduction of Taungya system into the humid tropics was a response to various socio-economic factors. For example in Nigeria, a major objective was to solve the problem of high cost of forest regeneration. One benefit of shamba system is low cost of plantation establishment. Taking wage of kshs 80.00 and current task rates, costs of establishment of plantation per hectare compounded at 15% to the end of 30 years rotation, was found to be approximately kshs 277, 000 for NRC areas. This means NRC is critical to economic development of plantations (World Bank Supervision Report, 1996). In 1990's FD reduced its staff through the retrenchment programme, which had an aim of reducing government expenditure. This means only a skeleton staff remains in the forests stations (Kagombe, 1998). Tree planting is faster as opposed to natural regeneration but a more costly way of restoring forest cover. Forest recovery is a slow process and when time is important forest plantations are economically and ecologically good alternative (Lugo, 1992). The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the

labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The study by G C Monela,, *et al*., 1991 on analyzing the taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

The cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. The table below shows the cost of plantation establishment for each method by 2007. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. However, the system was abused such that prohibited farming tools were used like non-specified crops were planted and penalties for wrong doers were not honoured especially for those who rented out plots to outsiders who were not interested in conservation (FD, 2005). Effective cost/benefit sharing of forest resources e.g. through introduction of PELIS to reforest indigenous forest areas is a positive step. This could be adopted within the REDD+ framework (MFW, 2015).

Table 2.1: Task rates from FD (2005)

Activity	Total cultivation shs	Slashing shs	Slashing and spot hoeing shs	No preparation shs
Clearing	10,000	35,000	45,000	0
Staking out	1,500	1,500	1,500	1,500
Planting spos	1,500	3,000	3,000	3,000
Planting	1,500	1,500	1,500	1,500
Yr 1 tending	10,000	3,500	4,500	0
Yr 2 tending	10,000	3,500	4,500	0
Yr 3 tending	10,000	3,500	4,500	0
Total cost	**44,500**	**51,500**	**64,500**	**6,000**

Source: Task rates from FD (2005)

2.7 Livelihood Improvement and Forest Cover

Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and the survival of plantation trees, it has also provided other significant benefits such as making available arable land for the landless and contributing to food production. Plantation establishment and livelihood improvement scheme (PELIS) a modified form of non-residential cultivation that was practiced in earlier years in Kenya as a method of plantation establishment GOK, 2005; GOK, 2006;FAO, 2006). PELIS was initiated with the objectives of fully rehabilitating and protecting the forest and improving the livelihood of the forest adjacent communities (GOK, 2005). According to (Kafu, 2002) the expected benefits from PELIS were numerous. First, there would be increased forest cover, increased volume of water from the catchment areas, increased food production and there would be improvement in living standards of the communities living adjacent to forest due to increase in household incomes (GOK, 1994). PELIS is meant to improve economic gains of participating farmers while ensuring success of planted trees.

Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water

resources which loses its quality as forests condition worsens (MEA, 2005). Fresh water catchment and soil preservation are important inputs to agriculture and food production. FAO should also arrange with the government of Kenya as host of the FAO regional conference for Africa (March, 2008), to include the key role of forestry in achieving food security on the agenda. (Geller *et al.*, 2007).

V.K. Agyemen,2003, also noted that food crops, especially annuals such as plantain, Cocoyam and Vegetables were interplanted with determined trees species. The food crops were normally cultivated for three years, after which the shade from the trees impeded further cultivation of the crops. Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

Apart from successes observed through the MTS in the regeneration of degraded forest resources, the livelihood assets received by local people through the MTS intervention have led to significant increase in food productivity, income levels and general well-being of most households in all communities studied (Osei W and Eshun G, 2013). Interventions such as the MTS reveal that central governing agencies alone cannot have adequate capacity to combat deforestation and forest degradation or even monitor it. Local peoples' participation becomes a necessity for the implementation of the REDD+ intervention and related climate change mitigation measures to be effective (Osei W and Eshun G, 2013). Under the traditional taungya arrangements, Ghanian farmers had no rights to benefits accruing from the planted trees (Milton, 1994) and no decision making role in any aspect of forest management (Birikarang,2001).

A case study done in Njoro area East of Mau forest indicated that farming community in this area utilize the plantation area to grow food crops especially vegetables during the dry season. (B, Wangwe at el). Shamba system gives high return to farmers by close to Ksh 120,00 per hectare per year it creates employment to farmers and ensures food security.

(Kagombe, 2009). Forest management is important for people who gain a livelihood from the forest because people can only have a stable source of livelihood if forests are sustainably managed. In that way people can overcome their vulnerability based on forests (Hoogenbosch, 2010)

The project (GZDSP) has improved the livelihood of the communities living adjacent to forests through support of income generating activities (IGAs) which they depend on for survival. The model they engage in while rehabilitating degraded sites is Plantation Establishment and Livelihood Improvement Scheme (PELIS) which provided for communities to cultivate the forest area and plant crops for up to three years as they tend for the seedlings in the rehabilitated area. Mr. Kemau of the many beneficiaries said that the project activities enabled him buy a motorbike and purchase a ten acre piece of land in Gathiuru which he has started to construct. The communities utilize grazing rights, PELIS and fuel wood collection among other forest activities (KFS, 2014)

Kenya Forest Service Director, Mr David K. Mbugua on 10th may 2014 made a tour of Olbolossat forest, Nyandarua Zone to view the progress on areas of forest plantation under the CFA using PELIS that spell from 2009 to date. From the same unit of forest land a total of approximately 3,500 community forest Association members of which 2000 are able to generate profit from sale of crops while the remaining 1,500 benefits from grazing and other activities, have made Olbolossat success story. The next day the board visited Timboroa Forest station where they were received by members of the community led by CFA officials who took the board through the benefits they have enjoyed from their symbiotic relationship with the service in the form of PELIS.

In the nearby Nabkoi Forest station the board also saw the huge plantation backlogs that are typical of many areas where a shortage of resources caused backlogs (KFS, 2014). Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and survival of the plantation trees, it has also provided other benefits such as making available arable land for the landless and contributing to food production (Paul Okelo Odwori, Phillip M. Nyangweso and Mark O. Odhiambo, 2013). Under PELIS, CFA is allocated a piece of forest and where plantation trees are intended to be raised. The CFA shares it out among its members with each paying a small royalty. The farmers grow crops for food and for sale. In the second year (season) the farmers' plant preferred trees with the aid of KFS managers on the same piece of land.

In this way, farmers improve their food security, have some surplus for sale to get

income and their livelihood improve. (D. Walubengo and M Kinyanjui, 2010). It is a joy for farmers to benefit from PELIS as some people small pieces of land whose productivity is low can now generate enough profits to raise even wealthy families (R.Manyaka, 2015). Wanyoike said that since 2005, they have been farming on portioned acre producing high volume of potatoes and thus fetching good returns hence has significantly improved their living standards. “We have uplifted our living standards and we are so happy about it. Having a piece of land here (Aberdare Forest) to farm has created employment for us and we are making good profits” she said.

‘The MTS has been of immense benefit to the entire community, I could find majority of the youth in senior high school because their parents are now able to afford .Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small. Almost every member of this community involved in the MTS is able to grow more food stuffs for their household's consumption and for sale to earn some money to take care of their households. As for the trees we are willing to plant more and manage them well all we need from government is for us to have land and released to us on annual basis. Because we know that when trees are well taken care of ,they protect ourselves and the 40 percent benefit to MOTAG farmers who manage the trees well until maturity can support our children in the future EVEN when we are not alive" (Prince Osei *et al*., 2008).

Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars. “PELIS is offering communities an economic boom. Many CFAs are making millions from cultivating in the acres allocated to them” said Simiyu Wasike, deputy Director in charge of plantation and enterprise at Kenya Forest service. It a system promoting, plantation establishment, food security and better livelihood in the country and more than 185 CFAs exist in the country summing up the members exceeding 10,000 Wasike says (R. Manyaka 2015). Gerald Ngatia executive director for National Alliance for community Forest Association (NACFA), says successful PELIS is a major boosts to hundreds with of small scale farmer across the country. ‘Not only does PELIS create jobs for many but it greatly contributes to food security in the country. “Said Ngatia (R manyaka 2015).

2.8 Theoretical Framework

This study related two theories i.e. forest transition theory and environmental Kuznets curve theory.

2.8.1 Forest Transition Theory (FT)

The theory describes a sequence over time where a forested region goes through a period of deforestation before the forest cover eventually stabilizes and start to increase. This sequence can be seen as a systematic pattern of change in agricultural and forest land rents overtime. Increasing agricultural rent leads to high rate of deforestation. In describing how forest cover changes through the development phases of a country, this concept of forest transition is useful in depicting such changes. In that regard, the forest transition (FT) model describes the overall human induced changes of forest cover overtime and basically presents the combined effect of various drivers of on a national scale. The concept was proposed and articulated by Mather (1992) and later expanded by Rudel (2005) and (Kauppi *et al.*, 2006).

The model basically shows the transition in which a country with 40% forest cover goes through phases of decreasing forest cover through human activities till a period of maximum decrease before a country realizes that it can no longer afford to lose more forest cover and at which time, it begins to stop further net loss of forest cover and put in policies and measures to increase forest cover, in the case of Kenya the policy is PELIS. Graphically the trajectory is described at the national level by inverse J-shaped curve overtime. Furthermore the entire inverse J-shaped curve can be broken into four phases namely: pre-transition, early transition, late transition and post transition phase. These phases generally represent a time sequence of national development (Hnosuma *et al*., 2012).

In Africa subsistence agriculture remains the dominant driver but the effect of commercial agriculture is likely to increase in early transition. Countries such as Angola, DRC, Zambia and Mozambique with respect to forest degradation, logging accounts for 52% fuel wood and charcoal 31%, fire 9% and livestock grazing 7%. The Kenya forest service can use its position on the curve for purposes of policy advocacy for the forest sector in general and for REDD+ in particular. Honosuma *et al*., (2012) observed that the phases of transition are associated by drivers of varying significance as listed herein;

1. Agricultural expansion dominates the early and the late transition phases.
2. Fuel wood and fires- become more dominant in late and post transition phases.
3. Subsistence agricultural- fairly stable over all phases.

4. Urban expansion-largest in the post transition phase.

In general, nature the study notwithstanding, the study by Honosuma *et al*. 2012 places Kenya in the late transition phase in generalizing transition curve.

2.8.2 Environmental Kuznets Curve Theory

The second theory that also relates to forest cover is environmental Kuznets curve that contends that a U-shaped relationship exists between environment quality and economic development. The theory relates forest cover as key indicator of environmental quality and income levels.

2.8.2.1 Forest and the Natural Environment

Forests have been a source of life from time immemorial. A part from being the basis for a variety of wood and non-wood products and services forests are home to many forms of life and an essential role environmentally, including climate regulation, carbon recycling, bio diversity preservation and soil and water conservation. Biodiversity is widely recognized as a major source of sustainability, indicator may be identified to help detect human impact on nature including the health of ecosystem, the functionality of watersheds and so on.

2.8.2.2 Environmental Quality and Economic Well being.

On the basis of framework of Kuznets (1955) proposition asserts that economic growth may be harmful to the environment before reaching a certain stage but becomes conducive afterwards. Hence the relationship assumes a U-shaped. (Arrow *et al*. 1995).. The curve indicates that as the economy grows, environmental degradation increases up to certain level after which environmental quality improves. This means that at low income levels, environmental quality tends to decline along with economic growth, but ultimately improves as income levels rise beyond a threshold. The U-shaped relationship is dictated by the ability to spend on environmental amenities implying that wealthy countries have lower levels of environmental damage because they can afford to pay for environmental improvement, whereas poor countries cannot afford to emphasize amenities over material well-being.

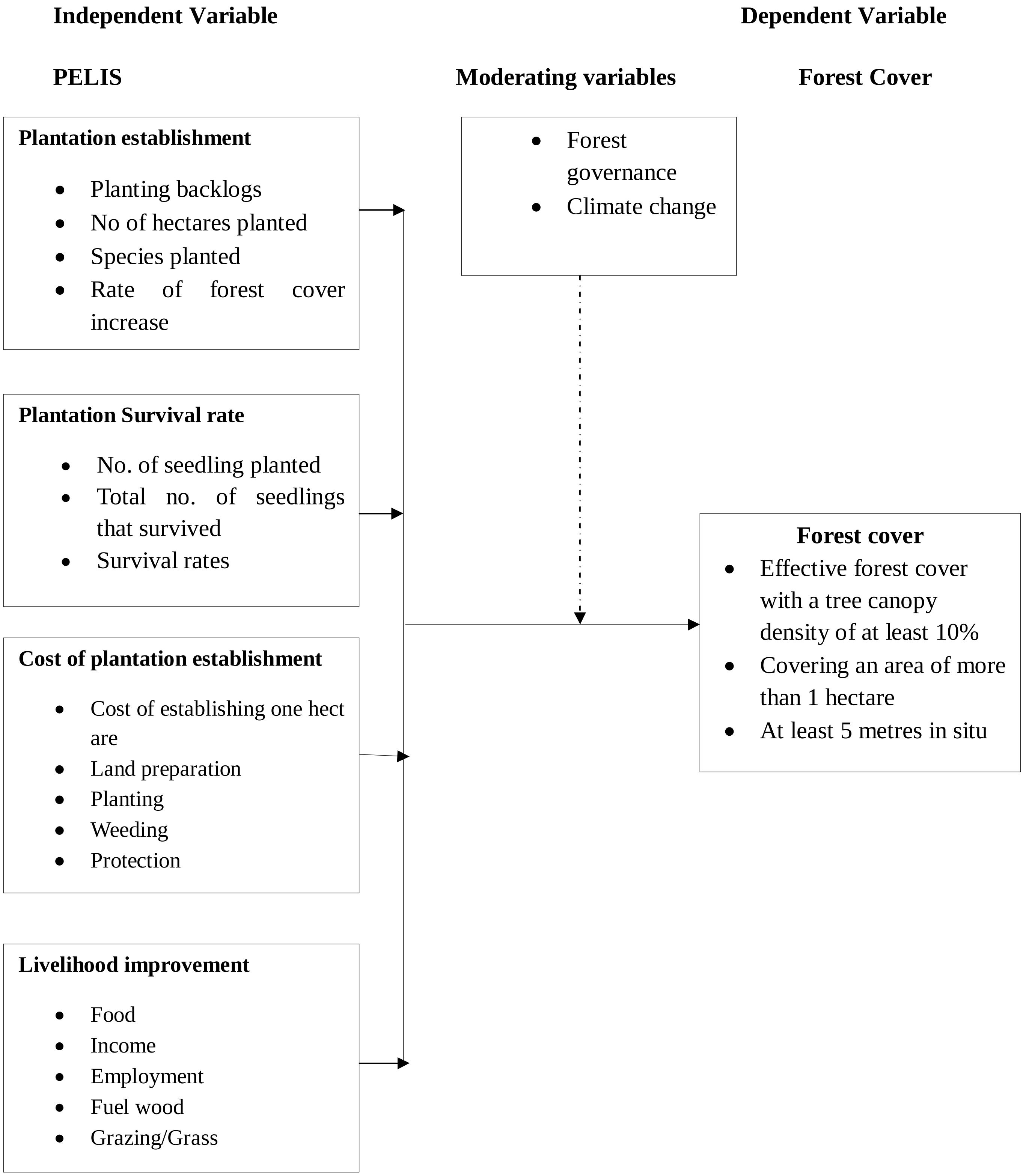
2.8.2.3 Is Forest Cover Related to Income Levels?

Human beings depend on forests for a variety of purposes. Population growth results in higher demand for forest based products and services. Therefore, it is reasonably to

postulate that population increase is a fundamental driving force of change in forest cover. (Mather *et al*. 1999) suggest that there is a theoretical basis for linking long term trends in forest use with economic developments including the emergence of forest transition as a society's income rises. Change in the state of the forest is subjected to a certain set of appropriate and constraints and income levels. From the perspective of developing countries, unless the gap between global diversity benefits and the needs of local people is narrowed the required economic growth will occur at the expense of much of the planets biodiversity (Fuentes-Quezada, 1996).

2.9 Conceptual Framework

Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced in the Kenya's forestry sector to specifically alleviate planting backlogs, increase plantation survival rate, reduce cost of plantation establishment and improve the livelihood of the adjacent communities through food security. Its overall key objective was to increase the forest cover. The table below shows the two variables and their indicators.



(Source: Researcher, 2015)

Figure 1: Conceptual framework

Independent variable is PELIS while dependent variable is forest cover in this study. There are four factors that influence forest cover, and they include; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. The PELIS indicators would be the number of hectares planted, plantation survival rate, the cost of plantation establishment and the number of bags of maize and potatoes harvested. While on forest cover the indicator would be the area under forest cover in percentage. However, there are some other external factors that may behave like independent variable and has contributory effect on the relationship between independent and dependent variables. They include; forest governance and climate change factors. These factors could be termed as moderating variables.

On forest governance, if there are no proper rules, regulations, policies and code of ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, and prolonged dry spell. These will eventually lead to forest destruction and degradation hence forest cover loss.

2.10 Gaps in Literature Review.

The literature review on PELIS covered by this study has largely focused on its influence on food security to the forest adjacent communities and availing arable land to the landless. A wide knowledge gap of PELIS influence on forest cover is conspicuously missing and if available but only by mentioning. It is on this backdrop that this study will come handy for the policy makers in making informed policies and decisions besides ensuring sustainable production of the various forest products and services to the forestry sector players in the country.

MFW (2012) identified lack of clear policy on cost and benefit sharing that is not covered in the current Forest Act 2005. This is hindering afforestation and protection efforts by the key stakeholders as they feel they are short changed. Need for review of technical orders on spacing to increase the time farmers cultivate plots before canopy closure. Lack of stringent harvesting procedure is also escalating over logging, this include lack of felling and plantation establishment plans or look warm implementation in areas where they exists. (MFW, 2012).Lack of incentives to CFA members involved in PELIS make them less accountable to the programme rules and regulations. Conflicting sectoral policies e.g. Water

Act, Agricultural Act and EMCA, 1999 Act on wetlands protection. All these needs further research so as to ensure that all these bottlenecks are addressed.

Table 2.2: Knowledge Gaps

Thematic area	Author (s)	Method	Main findings	Knowledge Gaps
Influence of plantation establishment and livelihood improvement scheme on livelihood of Gaithiuru forest, Nyeri.	Mwatika N M (2013)	Descriptive research design that targeted CFA member	Study found that PELIS had a positive influence on livelihood of forest adjacent communities. The scheme diversified sources of livelihood, enhanced social and human capital.	The researcher did not study the influence of PELIS on forest cover. This study will explore how PELIS contribute to forest cover through enhanced area established with plantation.
Forest reclamation, REDD readiness and community livelihood sustainability. Assessing the viability of modified Taungya system as a decentralized Nature governance strategy.	Prince Osei Wusu Adjei and Gabriel Eshun (2008)	Survey method that targeted a total of 150 respondents in four forest fringe communities in a district in Ghana about their own forest and how it is governed.	Community participation in forestry decisions through the MTS enhances community resilience to combat climate change through improved community forest cover and livelihood.	The research targeted on modified taungya system as adecentralised nature governance strategy. This study will focus on the influence of PELIS on forest cover through plantation establishment, plantation survival rate and costs of plantation establishment.
Plantation establishment in Kenya – The shamba system case study	Joram K Kagombe and J M Gitonga (2005)	Survey method that targeted selected five districts	Total cultivation for plantation establishment is expensive but gives the highest survival and growth rate .	The study never focused on the influence of NRC on forest cover. This study intends to determine how much area has been established through use of PELIS

Challenges facing forest plantation establishment through shamba system; the case of Mucheene forest.	Ikiara, Isaac G (2010)	Survey method that targeted cultivators of six CBOs	There was adherance to the shamba system policy guidelines and community participation.	The study did not establish the influence of plantation establishment, plantation survival rates and cost of plantation establishment on forest cover.
Alleviating Food Insecurity and Landlessness Through PELIS in Kenya	Paul O. Odwori, Phillip M. Nyangweso and Mark O. Odhiambo (2013)	Purposive sampling was used to identify forest zones that practice PELIS in Kenya	PELIS contribute up to 2,049 hectares of arable land to the landless and up to 3 million bags of maize	The researcher did not focus on the influence of PELIS in increasing forest cover hence basis of this study.

2.11 Summary of Literature Reviewed

The study gathered literature from a wide range of authors whose studies were mostly based on the influence of PELIS on the livelihood of the forest adjacent communities but not on forest cover. PELIS has a number of components, some of the key components highlighted in this study include: plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. During literature review the four components were found to influence forest cover. With regard to the influence of plantation establishment on forest cover the literature reviewed showed that indeed there is influence but was not discussed at length. On influence of survival rate on forest cover many authors established that well weeded, fertilized and protected plantations improved survival rates. Little literature was established with regard to the influence of cost of plantation establishment on forest cover, as farmers were providing labour for free from land preparation to protection and this was made possible because farmers were tending their crops too. Most researchers reviewed literature on the influence of PELIS on livelihood improvement of the forest adjacent communities but not livelihood improvement on forest cover. It is therefore important that the literature reviewed in this study will go a long way in bringing out the link between PELIS and forest cover.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter entails research design, target population, sampling design / procedure, sample size, data collection instrument, data collection procedure, measurement of variables, reliability test, and validation of instrument, data analysis, anticipated outcome and ethical considerations.

3.2 Research Design

This study explored survey research design. .It uses primary and secondary sources and qualitative data sources e.g. diaries, official records, reports etc. Survey is the systematic means of collecting information from people that generally uses a questionnaire (Grewal and Levy, 2009). Given that the study largely relied on the secondary data from the government offices and administering of interview schedules and questionnaires to the forest managers and the CFA members respectively hence it was necessary to use the research design.

3.3 Target Population

Target population was 6521 which included 6515 CFA members and 6 forest station managers. The study focused on plantations established 2001-2007, without PELIS and plantations established 2008-2014 with PELIS.

Table 3.1: Target population

Strata	No of CFA members	No of forest station managers	Total
Kapsaret	403	1	404
Cengalo	1650	1	1651
Nabkoi	1804	1	1805
Kipkurere	852	1	853
Timboroa	1406	1	1407
Lorenge	400	1	401
Sub –Total	**6515**	**6**	**6521**

3.4 Sampling Procedure and Sample Size

3.4.1 Sampling Procedure

Simple random sampling method was used in the two population groups because it is considered simple, most convenient and bias free. Every member of the population has equal and independent chances of being selected as respondents (Frankel *et al*, 2000). Sampling is a procedure of selecting a part of the population on which research is to be carried out, which ensures that conclusions from the study can be generalized to the entire population. Since the forest station managers were few, the researcher used non probability technique which is purposive sampling design to select the six forest station managers. (Leedy, 1993) observed that nothing comes out at the end of a long and involved study that is any better than the careful selection of the population using random sampling and stratified random sampling.

3.4.2 Sample Size

Given that the target population is less than 10,000 hence to calculate the final sample (Nassiuma 2000) sample size formula will be used. According to (Nassium, 2000) in most surveys , a coefficient of variation is the range of 21% ≤30% and standard error in the range 2% ≤ e ≤ 5% is usually acceptable. Therefore the study will use a coefficient variation of 30% and a standard error of 2%. Nassium (2000), gives the formula as follows; $n=Nc^2/c^2+(N-1)e^2$. Where; n= Sam ple size, N= population, c= covariance, e= standard error.

$$n = \frac{6515(0.3)^2}{0.3^2+(6515-1)\ 0.02^2} = 218.$$

Target population sample size is 218.

By using this formula a sample size of 6 and 218 for forest stations and CFA members will be used respectively. Below, is the table summary for target population in each study area and corresponding sample taken from each area. The study will use Neyman (2000) formula for stratum sample size allocation, Nh - (Nh/N) * n where sample size for stratum h, Nh= population size stratum h, N = total size of population, n= total sample size.

Table 3.2: Sample size for target population

Strata	CFA Members	Sample Size	Forest Managers	Sample Size	Total Sample Size
Kapseret	403	14	1	1	15
Nabkoi	1650	55	1	1	56
Cengalo	1804	60	1	1	61
Kipkurere	852	29	1	1	30
Timboroa	1406	47	1	1	48
Lorenge	400	13	1	1	14
Sub-Total	**6515**	**218**	**6**	**6**	**224**

Random sampling method was used to sample the CFA members for each forest statio n .This was done by assigning random numbers to them.

3.5 Data Collection Instruments

The study employed both primary and secondary sources of data, which included questionnaires, interview schedule and personal observations. In the case of secondary data, office records like statistical reports, scholarly journals, thesis, diary, and pamphlets, were used as well as Worldwide Web, text books, newsletters and magazines. Questionnaires as a primary source was used for data collection from the CFA members and interview schedules were used for forest station managers .A questionnaire is a form that features a set of

questions designed to gather information from respondents and whereby accomplish the researchers' objectives (Grewal and Levy,2009).

The questionnaires were structured. It is relatively economical method in cost and time, of soliciting data from a large number of people and the time for checking on facts and pondering on questions can also be taken by respondents, which tend to lead to more accurate information (William, 2005). Each item in the questionnaire is developed to address specific objectives, research questions or hypothesis of the study. The respondent is expected to react usually in writing. It assists in collection of information over a short period of time when time is a limiting factor.

The researcher personally together with competent assistants administered the questionnaires and the interview schedules so as to be assured of relatively uniform mode of questioning and questioning and subsequent respondents. The questionnaires were in two parts, Section A was about demographic information and Section B was about CFA food production activities through PELIS and plantations establishment 2001-2014. The study also employed face to face interview and personal observations from the six forest station managers to get clarity on some secondary data gathered from the office records. The reason for using interviews was that they are easy to administer since questionnaires are already prepared .The investigator follows a rigid procedure and sought answers to a set of pre-conceived questions through personal interviews (Kothari, 2004).

They also eliminate many sources of bias common to other instruments. This is because questions asked are usually confidential between the researcher and the respondent. Interviews clarify points that are not clear, collected from key informants by use of interview schedules. Interview schedule is important because it helps eliciting in depth responses that may enable deep understanding of the research problem. The interview schedules are comprised of A which is about demographic information while section B up to F about the four study objectives. Personal observations will also be employed in assessing the status of the plantations. This is where the researcher uses all the senses to perceive and understand the experiences of interest. It gives firsthand experience without respondents information as it occurs, explains topics that may be uncomfortable to respondents and notice unusual aspects. The researcher uses an observation checklist to record what he observes during data collection.

3.5.1 Pilot Testing of Instruments

A pilot study was carried out at one of the six forest stations and it's CFA. This was purposely to confirm the reliability and validity of the research instruments .The researcher also verified that ambiguous information was removed while deficiencies and weaknesses were be noted and corrected in the final instruments (Croswell & Miller; 2000). The main aim was to ensure clarity and suitability of the instruments that were used in the study. Reliability and validity is about usability of the instruments as it is about ease with which instruments can be administered, interpreted by participant and scored/interpreted by researcher. Usability considerations include how long it will take to administer, are directives clear, how easy is it to score etc.

3.5.2 Validity of Research Instrument

It is the extent to which an instrument measures what it is supposed and performs as it is designed to perform. This involves collection and analysis of data to asses accuracy of an instrument. It is prudent to use instruments from previous studies to ascertain content validity. It is one that has been developed and tested several times. It is about appropriateness of the content of an instrument. It should measure what one wants to know. To confirm this both the questionnaires and the interview schedules were tested by administering the same.

3.5.3 Reliability of Research Instrument

It refers to stability or consistency of measurement; that is whether or not the same results would be achieved if the test of measure will be applied repeatedly (Someh and Lewin, 2007) Reliability test of the instruments was done using cronbach alpha co-efficient. Nunally (1967) suggested that the minimal uptake reliability of 0.7 is recommended. To ascertain the reliability of the questionnaires, the researcher administered 10 questionnaires and two interview schedules for two CFA groups and two forest managers respectively. The modes of responses to the instruments were consistent and even time taken to answer the same.

3.6 Data Collection Procedures

The process of data collection commenced once the necessary certifications had been completed. The researcher sought permission from National Council for Science and Technology and finally got authority from the County Commissioner, Eldoret to carry out

research in the identified area. The researcher personally with the assistance of competent assistants administered the research instruments to the respondents after familiarization and informing the respondents of the purpose of study. Appointments were booked for various dates for data collection. The interview schedules for forest station managers were personally administered by the researcher. He also personally together with the assistants distributed the questionnaires and the completed instruments were verified and collected from the respondents.

3.7 Data Analysis

The data collected from both primary and secondary sources were checked for completeness, accuracy and relevance. SPSS was used to analyze the data. Descriptive statistics were used in analysis and presented in tables, frequencies and percentages. Also used were measures of central tendencies and dispersion where applicable.

3.8 Operationalisation of Variables in the Conceptual Framework

Table 3.3: Operationalization of Variables

Objective	Indicator	Measurement Scale	Tools of Analysis
To establish the influence of plantation establishment on forest cover in Uasin Gishu county.	-No of hectares established -No of species planted	Ratio Nominal Ordinal	Means, frequencies and percentages
To determine the influence of plantation survival rate on forest cover in Uasin Gishu county.	-No of seedlings established -Total number of seedlings that survived	Nominal Ordinal	Means, frequencies and percentages
To investigate the influence of cost of plantation establishment on forest cover in Uasin Gishu county.	-Cost of establishing one hectare	Ratio Ordinal Interval	Means, frequencies, percentages and standard deviation
To assess the influence of livelihood improvement on forest cover in Uasin Gishu county.	-No of bags of maize produced per acre -No of bags of potatoes produced per	Nominal Ratio Ordinal	Means, frequencies, percentages and standard deviation

	acre -No of bags of beans produced per acre -No of farmers who benefit from employment opportunities created -No of farmers who collect fuel wood from forest -Amount of money earned from sale of crops -No of farmers who cut grass/graze in the forest	

Source: Researcher (2015)

3.9 Ethical Considerations

To ensure compliance with ethical consideration the researcher sought permission from the relevant authorities. The respondents were given introductory letter for their permission to participate in the study. The names of the respondents were not disclosed unless on mutual agreement. All confidentialities of the respondents were not disclosed to the third party. The researcher observed honesty and practiced integrity (Shamhoo and Resnik, 2009). The data results, methods and procedures and probabilities were honestly reported by the researcher .Biasness was avoided in data collection, analysis and interpretations. The researcher avoided careless errors and negligence, being critical in examination of findings so as to keep good records of research activities.

CHAPTER FOUR

4.0 DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

Chapter four gives detailed data analysis, presentation and interpretations of the study findings. Data was collected and analyzed through the use of descriptive and inferential statistics. The data was then presented in tables. The discussion of the findings enabled the researcher to make inferences on the influence of PELIS in promoting forest cover. The study findings were then linked to the researcher's opinion in relation to the existing knowledge for close interpretation and discussion. The chapter is organized into sections beginning with presentation of the respondents' background information and the subsequent sections have been organized to follow the research objectives. There were a total of 224 people including 6 forest station managers and 218 CFA members involved in this study through the use of questionnaires and interview schedules.

4.2 Respondents Return Rate

4.2.1 Respondents Return Rate for Forest Managers

All the six forest station managers completed the interview schedules which represented 100% response rate. This response rate was enough to give the researcher confidence to carry on with the study. Table 4.1 shows the distribution of the response return rate amongst the six forest managers.

Table 4.1: Response rate for Forest Managers

Respondents	Sample	Response rate	Percent (%)
Kapsaret	1	1	100
Nabkoi	1	1	100
Cengalo	1	1	100
Kipkurere	1	1	100
Timboroa	1	1	100
Lorenge	1	1	100
Total	**6**	**6**	**100**

All the six interview schedules were returned filled. This very positive response could have been due to the use of purposive sampling technique that ensured all the six forest managers responded to the interview schedule as this was a small sample size. A wealth of experience and knowledge by the forest managers also contributed to the excellent response. The personal administering of the interview schedule by the researcher also significantly influenced the impressive return rate. Brief and precise interview schedules enabled the managers not to fill bored.

4.2.2 Respondents Return Rate for CFA Members

All the 218 CFA members sampled completed the questionnaires which represented 100% response rate. This was significant to allow the researcher to continue with the study. The table below shows the respondents return rate for CFA members..

Table 4. 2: Response Rate for CFA Members

Respondents	Sample	Response rate	Percent (%)
Kapsaret	14	14	100
Nabkoi	55	55	100
Cengalo	60	60	100
Kipkabus	29	29	100
Timboroa	47	47	100
Lorenge	13	13	100
Total	**218**	**218**	**100**

The researcher employed five competent assistants in each forest station who assisted in administering of the questionnaires to the CFA members. This enhanced coverage hence the positive response. The use of brief and precise questionnaires ensured the respondents were not fatigued. The questionnaires were also semi structured hence easier to comprehend and took little CFA members time. This response rate was considered reliable to make conclusions from.

4.3 Demographic Background of Respondents

4.3.1 Forest Managers

4.3.1.1 Level of Education

Given that education is a prerequisite for effective sustainable management of forest resources, the study established the education levels of the forest managers as 3(50%) had diploma as highest education level, 2(33.3%) had undergraduate education and 1(16.7%) had post graduate education. The mean number of years of working experience was 4.4. Table 4.3 indicates the education levels of the forest managers.

Table 4.3: Highest education level

Education level	Frequency	Percent
Diploma	3	50
Undergraduate	2	33.3
Postgraduate	1	16.7
Total	**6**	**100**

Education level and experience are critical tools in sustainable forest management as the manager is able to make sound decisions, interpret and implement policies and regulations that govern forestry practice). It also helps in efficient and effective management of resources both human and material. It is on this strength that the government is encouraging employees to scale up their level of education through gaining of more skills, knowledge and experience by offering study leaves and scholarships.

4.3.1.2 Age Distribution

The table below shows the age distribution of the forest managers. It was observed from the study findings that majority of them are in the age bracket of Over 50 years at 3(50%), 41-45 years 2(33.3%) and 46-50 years 1(16.7%).

Table 4.4: Age Distribution of Forest Managers

Category	Frequency	Percent (%)
18-25 years	0	0
26-30 years	0	0
31-35 years	0	0
36-40 years	0	0
41-45 years	2	33.3
46-50 years	1	16.7
Over 50 years	3	50
Total	**6**	**100**

Nzuve, (2010) observed that one of the key ingredients to an organizations strength and growth is having the right people in the right place at the right time. From the findings it was noted that majority of the forest managers were aging as there was none in the age bracket of 40 years and below. This poses a threat to succession and continuity of the organization. Positively age reflects the experience that one has gained over the years which is significant for increased effective and efficient productivity. There is likelihood of low productivity as the aging employees would tend to focus more on his forthcoming retirement as opposed to concentrating his efforts in working towards the achievement of the organization objectives.

4.4 Demographic Background of Community Forest Association Members.

4.4.1 Gender Distribution

Gender distribution is vital to forest management and conservation as each gender is well suited for specific activities. It was established from the study that 130(59.6%) CFA members were females while 88(40.4%) were males. Table 4.5 below depicts gender distribution for the CFA members.

.Table 4.5: Gender Distribution

Category	Frequency	Percent
Male	88	40.4
Female	130	59.6
Total	**218**	**100**

The study showed that the biggest population of the CFAs are females, who participate in PELIS, culturally the societies expects females to be in the forefront to ensure that food is available to the children and the family at large hence the increased percentage. It is them who spent most of the time with the children as opposed to the males.

4.4.2 Age Distribution

Most forestry activities are labour intensive especially PELIS. This would mean that energetic people take the forefront. It was established that majority of the CFA members were in the age bracket of 36-40 years with 112(51.4%), 41-45 years 30(13.8%), 46-50 years 25(11.5%), over 50 years 21(9.6%), 31-35 years 20(9.2%), 26-30 years 10(4.6%) while there was no representation in age category of 18-25 years. Their mean age (in years) was 38.4 with a range of (min 18, max 72). Table 4.6 shows the age distribution of the CFA members.

Table 4.6: Age Distribution of CFA Members

Category	Frequency	Percent
18- 25 years	0	0
26-30 years	10	4.6
31-35 years	20	9.2
36-40 years	112	51.4
41-45 years	30	13.8
46-50 years	25	11.5
Over 50 years	21	9.6
Total	**218**	**100**

It is evident from the study findings that majority of the farmers are at their prime age hence able to effectively use their energy in food production for their families. It is also important to note that at age 41 years the number of farmers starts to decrease, this could imply subsequent decline in energy and vigour. There is also low representation in ages between 18-35 years, as this could also imply that this youthful age; the youth are engaged in either schooling or other sources of income.

4.5 Plantation Establishment and Forest Cover

4.5.1 Planting backlogs

A huge planting backlog is an indicator of large unstocked plantation areas. There was a total backlog of 6066 hectares as at 2008 while as at 2014 there was 1,935.6 hectares. This represented 18.8% (2008) and 6 %(2014) respectively. The total forested area was 26,141.9 hectares as at 2008 and 30,272.3 hectares as at 2014 as indicated in table 4.7 below illustrates the planting backlogs.

Table 4.7: Planting Backlogs

Year	Total forest Area (Ha)	Forested are a (Ha)	Backlog (Ha)	Percent
As at 2008	32,207.9	26, 141.9	6066	18.8
As at 2014	32,207.9	30,272.3	1,935.6	6

The findings from the study established that planting backlog reduced from 18.8% to 6% as at 2008 and as at 2014 respectively. This represented a decrease of 60% in planting backlog. This development could be attributed to the influence of PELIS as a strategy in increasing forest cover. As the CFA members are allocated plots to cultivate their crops they also assist in planting and weeding tree seedlings alongside accepted agricultural crops.

4.5.2 Area Established through PELIS

The table below covers the area that was established 2008-2014 when PELIS as a strategy was introduced at the forest stations. The study shows that there was a steady increase in area of plantations established using PELIS strategy i.e. 2008(4.3%), 2009 (6.96%) ,2010(11.75%) ,2011(18.46%) 2012(12.78%),2013 (21.18%) and 2014 (24.56%).

Table 4.8: Area Established through PELIS

Year	Area Established (Ha)	Percentage (%)
2008	177.6	4.30
2009	287.4	6.96
2010	485.4	11.75
2011	762.6	18.46
2O12	528	12.78
2O13	874.8	21.18
2014	1014.6	24.56
Total	**4130.4**	**100**

It was noted from the analysis that a total of 4130.4 hectares was established with PELIS from 2008-2014. It is only 2012 (12.78%) which revealed reduced establishment area that could have been due to anticipated general election for 2013, prolonged drought and transfer of forest managers. The planting backlogs stood at 1935.6 hectares as at 2014 that could have been due to continued plantations felling that do not correspond to plantations establishment rate following the lifting of the logging ban in 2012 by the government and lack of approved felling plans as indicated in table 4.2 above. The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation. (O.A. Ndomba *et al.*; 2014). V. K. Agyeman at el., 2003, established that about 78 percent of Ghana current total area of commercial public and private forest plantations

of 35, 000 ha were established using the taungya system.

Hoefsloot *et al.*, (2011) observed that although Shamba system existed in the years 2007 and below, it was abused by the implementers and never had stringent rules and regulations to govern it as PELIS does. However, as part of conservation efforts to replenish the forest cover, members of the CFA are supplied with certified seedlings, which they plant in the allocated portions and tend to them during cropping season (R.Manyaka, 2015). The area under PELIS increased from 2933 hectares in 2010/2011 financial year to 9939 hectares in 2012 /2013, according to the statistics by KEFRI (R Manyaka, 2015). The official said the scheme is a driving force in replenishing the forest cover while giving communities an opportunity to enjoy the forest economic benefits (R. Manyaka, 2015). Mr. Mwanzia the project manager (GZDSP) noted that the issue of ownership by community has improved rehabilitation efforts as there are fewer planting backlogs (KFS, 2014).

4.5.3 Major Species Planted

The table below shows the major tree species grown in the state forests. The study findings revealed that the species compositions were: *Cupressus lusitanica* 2,424.5 ha (58.7%), *Pinus patula* 1,086.3 ha (26.3%), *Eucalypts* 375.9 ha (9.1%) and indigenous 243.7 ha (5.9%).

Table: 4.9: Major Species planted

Species	Area established (Ha)	Percentage (%)
Cupressus lusitanica	2,424.5	58.7
Pinus patula	1,086.3	26.3
Eucalypts	375.9	9.1
Indigenous	243.7	5.9
Total	**4130.4**	**100**

The major species grown for industrial plantations and conservation in all the six forest stations included: *Cupressus lusitanica*, *Pinus patula* and *Eucalypts* species, all exotic. On conservation front, the common indigenous species included *Podocarpus falcatus*, *Podocarpus latifolius*, *Juniperus procera*, *Vitex keniensis*, *Olea* spp etc.The indigenous species are planted along catchment areas, degraded sites and for biodiversity conservation.

4.5.4 Rate of Increase in Forest Cover due to PELIS

The total forested area of the six forest stations was 32,207.9 hectares. Given that the total area established with plantations by 2014 was 4130.4 hectares, it therefore means that the percentage increase in forest cover during the PELIS period was 12.8%. Comparatively the percentage increase in forest cover without PELIS was 7.8%, this was from a total area of 2502.4 hectares of plantation established. Table 4.9 below illustrates the rate of increase in forest cover as a result of PELIS.

Table 4.10: Rate of increase of forest cover due to PELIS

Category	Total forest area (ha)	Area planted (ha)	Percent
As at 2008 (NO PELIS)	32,207.9	2,502.4	7.8
As at 2014 (PELIS)	32.207.9	4,130.4	12.8

According to the study findings on table 4.7 on the influence of plantation establishment on forest cover, there was an increase of 12.8% of forest cover following the planting of 4130.4 hectares of planting backlogs as at 2014. This therefore means indeed PELIS significantly contributed to forest cover as CFA members were allocated plots in clear felled areas and other open suitable areas to cultivate their crops; they too assisted in planting tree seedlings in the plots and tended them until canopy closure at about three years. By doing this KFS was able to realize plantation establishment of large areas as indicated by the study findings. As the farmers provided labour freely for land preparation, land cultivation, pitting, planting, weeding and protection. A well managed PELIS can significantly contribute to attainment of 10% forest cover by 2030 as envisaged in the vision 2030 and the constitution. Comparatively, the areas that were established without PELIS were low i.e 2502.4 (7.8%) hectares compared to 4130.4 (12.8%) hectares, area established with PELIS during the same period. This could have been low due to grassland planting that emphasized spot hoeing and spot weeding. There were also subsidy from multinational companies like Timsales, Pan Paper Mills and Raiply as they would provide funds for reforestation programmes of cleafelled areas. However, these have since stopped.

According to (FRA, 2015), the rate at which the world is losing its forests has been halved, but an area of 129 million hectares of South Africa has still been lost since 1990, UNs Food and Agriculture Organization report says. Improvement has been seen around the globe, even in the key tropical rainforests of South America and Africa. "FRA, 2015 shows a

very encouraging tendency towards a r education in the rates of deforestation and carbon emissions from forests and increases in capacity for sustainable forest management", said FAO director general Jose Graziano da Silva. Halting deforestation is a key focus of UN negotiations for a global pact limit disastrous climate change caused by greenhouse gas emissions.

The net annual rate of loss which takes into account the planting of new forests has slowed from 0.18 percent in the 1990s to 0.08 percent over the last five years. Planted forest area has increased by more than 110 million hectares since 1990 and now accounts for seven percent of the world's forest area (FRA, 2015). M Nicholson, 2000 observed that Kenya’s forest cover has tripled over the last 10 years increasing allaying fears of massive environmental degradation. According to government statistics released in March 2012, forest cover had risen from a low of 1.7 percent in 2002 to 5.9 per cent. The forest in both NP and FR which had been seriously degraded is now showing signs of recovery, pole stage trees are beginning to emerge from the climber tangles even where assisted regeneration had not been done earlier. (R Manyaka, 2015).

4.5.5 Plantation Establishment without PELIS

The study findings indicate that a total of 2502.4 hectares was established between 2001-2007 .It can be noted that is relatively low compared to the area that was established through PELIS 2008-2014 which was 4130.4 hectares. The largest area of plantation established was 474.6 hectares representing 18.97% in 2001 while the lowest was in 2002 with 199.8 hectares representing 7.98%. Table 4.10 below shows the plantations establishment without PELIS.

Table 4.11: Area Established without PELIS

Year	Hectares Established (Ha)	Percentages (%)
2001	474.6	18.97
2002	199.8	7.98
2003	372.6	14.89
2004	455.4	18.20
2005	328.8	13.14
2006	279.0	11.15
2007	392.4	15.68
Total	**2502.4**	**100**

The areas that were established without PELIS were low i.e 2502.4 (7.8%). Lack of funds from the government for reforestation programmes of clear felled areas was inadequate and this could have resulted to low plantation establishment coverage

4.6 Plantations Survival Rates and Forest Cover

4.6.1 Survival Rates of Plantations Established Through PELIS

The table below indicates the survival rates of plantation established through PELIS. From the study findings, the mean survival rate of plantations established with PELIS was highest in 2008(84.7%) and the lowest in 2013 (64.2%) as shown in table 4. 11. The study found that the survival rates of plantations established with PELIS were higher at 84.7% while without PELIS was 50.3%. The mean survival rate for plantations established with PELIS was 75.1%.

Table 4.12: Survival rates of plantations established through PELIS

Year	Area (Ha)	No. Of Seedlings Planted	No. Of Seedlings That Survived	Survival Rate (%)
2008	177.6	284,160	240,684	84.7
2009	287.4	459,840	338,442	73.6
2010	485.4	776,640	597,236	76.9
2011	762.6	1,220,160	920,000	75.4
2012	528	844,800	631,910	74.8
2013	874.8	1,399,680	898,595	64.2
2014	1014.6	1,623,360	1,245,117	76.7
Total	**4130.4**	**6,608,640**	**4,871,984**	**75.1**

The study findings could be attributed to the reduced competition for water and nutrients due to weeding, fertilization and low pruning done by the PELIS farmers. As the farmers weed their plots they too weed the young trees. As they apply fertilizers to their crops young trees too benefit from speel overs to the rooting system of trees. All these activities together with the protection the farmers provide to their crops, the young trees too are protected from straying livestock and wildlife hence increased survival rates.

Trees grown under PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI (Manyaka R, 2015). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012). The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004).

4.6.2 Survival Rates of Plantations Established without PELIS

The table below shows the various plantation survival rates in different years. The highest mean survival rate recorded was 50.3 %(2007) and 50.3 %(2005) while the lowest was 29.6% (2002). On average the survival rate for all plantations established without PELIS was 45.2%, table 4.12 below.

Table 4.13: Survival rates of plantations established without PELIS

Year	Area (HA)	No of Seedlings Planted	No. of Seedlings Survived	Survival rate (%)
2001`	474.6	759,360	325,006	42.8
2002	199.8	319,680	94,625	29.6
2003	372.6	596,160	250,387	42
2004	455.4	728,640	336,632	46.2
2005	328.8	526,080	264,618	50.3
2006	279.0	446,400	223,200	50
2007	392.4	627,840	315,804	50.3
Total	**2502.4**	**4,003,840**	**1,810,272**	**45.2**

These low survival rates could be attributed to competition for water and nutrients faced by tree seedlings. As seedlings are established in grassland through spot hoeing and poor spot weeding is done instead of complete weeding as in the case of PELIS. These tree seedlings also did not benefit from fertilization and protection provided by farmers. Grazing

and browsing by livestock and wild animals on young plantations caused mass death of the saplings hence low survival rates. There was no protection offered by the government as in the case of PELIS where farmers offered protection for both their crops and saplings. (table 13).

4.7: Cost of Plantations Establishment and Forest Cover

The study sought to find out if PELIS contributed to reduction in the cost of plantation establishment. From the study it came out that cost of plantation establishment for both with and without PELIS was 39,527/= and 50564/= per hectare respectively across all the six forest stations under study. This shows what KFS is saving Kshs 11,037 (21.8%) in establishing one hectare of plantation by use of PELIS. Table 4.13 below illustrates the above.

Table 4.14: Costs of plantation establishment

Category	Cost/ha without PELIS (Khs)	Cost/ha by PELIS (Khs)	Difference	Percent
Costs	50,564.00	39,527.00	11,037.00	21.8

The findings of the study established that the government could save up to Kshs 11,037 (21.8%) per hectare by use of PELIS. This money could be channeled to other activities like pruning. Given that farmers carry out array of activities at the preliminary stages of plantation establishment, the cost of establishing one hectare of plantation is reduced. The activities include land preparation, cultivation, pitting and planting. As PELIS farmers provide labour by carrying out the activities for free as they prepare land for their crops, the government saves a lot of money that would otherwise have been used to pay casuals.

According to FD, 2005, the cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. It was also established that multinational companies like Rai Ply, Tim Sales and Comply who are major consumers of forest raw materials insignificantly participate in reforestation of areas they have clear felled hence contribute to

continuous increase in planting backlogs. These companies should substantially compliment government efforts in reforestation in terms of raising seedlings and provision of funds for labour engagement during plantations establishment. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

4.8 Livelihood Improvement and Forest Cover

4.8.1 Main source of Livelihood

The illustration in table 4.14 is on the main sources of livelihood for the CFA farmers. They largely participate in PELIS to enhance their livelihood through diversification of sources of livelihood in form of more adequate income, increased wellbeing, and improved food security among others. It was established from the study that majority of the CFA members 210(96.3%) reported their main source of livelihood was farming -PELIS. Only 2.7% and 0.9% indicated business and employment respectively as sources of livelihood.

Table 4.15: Main source of livelihood

Category	Frequency	Percent
Farming-PELIS	210	96.4
Employment	2	0.9
Business	6	2.7
Total	**218**	**100**

The study showed that PELIS significantly contributed to food security for the forest adjacent communities as shown on table 4.14. The study findings established that 210 (96.3%) of the CFA members source of livelihood was farming-PELIS. Food security has been a challenge to our society especially the vulnerable segment. It is therefore notable that PELIS provided excellent opportunity to the poor as they are able to improve their livelihood by cultivating their crops in the forest alongside trees. By doing so they are able to secure

food for subsistence consumption and are able to sale the surplus for income so as to get other necessities of life like, clothes, shelter, food, education etc. The farmers too are able to graze their animals in the forest hence improved animal production for meat and milk and even sale for income. They are also able to get firewood and secure employment opportunities hence improved livelihood. Fresh water catchment and soil preservation are important inputs to agriculture and food production

Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

4.8.2 Shamba Ownership in the Forest

As illustrated in table 4.15 below, it was observed from the study that majority of the CFA members 214(98.2%) owned a shamba in the forest as shown in table 4.15 below. The average size of shamba owned by each former was one acre.

Among them 4(1.8%) that do not own a shamba, the reasons given were that two had not yet been allocated, one has no time to manage the farm while the other has his own farm.

Table 4.16: Shamba Ownership in the Forest

Category	Frequency	Percent
Owns forest land	214	98.2
Do not own forest land	4	1.8

The findings indicate that majority 214 (98.2%) of the farmers own plots in the forest. This could show that the main source of livelihood of the farmers was farming and also the shambas back at home were inadequate for both subsistence and commercial food production. For the farmer who does not own a plot in the forest, this could imply that the

farmer does only grazing or cut and carry grass in the forest but does land cultivation at home. The one that has not been given one is probably still new in the CFA membership and shambas are exhausted hence has to wait until the shambas are available i.e. until clear fell is done. For the 214 members that owned a shamba, the median (IQR) number of acres was 1 (0.5, 2). Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small (Prince Osei *et al*.2008).

Although PELIS was established to promote forest plantation development through enhanced forest establishment and survival of plantation trees, it has also provided other significant benefits such as making available arable land for landless and contributing to food security (Paul O Odwori at el., 2013).

4.8.3 Crop Harvest per Acre

The table below shows crop production per acre by the CFA members. On average, the PELIS farmers harvest 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre as shown in table 4.16.

Table 4.17: Crop harvest per acre

Category	Bags/acre	Max	Min
Maize	22	40	1
Potatoes	54	150	1
Beans	5	60	0.5

This means the farmers were able to get food from crop diversification and can dispose of the surplus to meet other family needs. It is on the basis of these crops that the farmers derive their livelihood from and the main driving force behind going for the government land.

4.8.4 Crops Grown Alongside Trees

From the study findings, the table below shows the response of CFA farmers if they grow their agricultural crops alongside trees. Majority of the members 202(92.5%) grew either crops alongside tree seedlings while only 16(7.5%) did not.

Table.4.18: Response of farmers on crops grown alongside tree

Response	Frequency	Percent
Yes	202	92.5
No	16	7.5

This means that PELIS ensured plantation establishment .However for the 16(7.5%) it could imply that their plots were in their first year of cultivation hence not ready for tree seedlings planting (table 4.17). The farmers are allowed to cultivate food crops which are planted between the trees on the same lands (Evans, 1992).

4.8.5 Types of Crops Grown.

As indicated in table 4.18 below, there are three main crops grown by CFA farmers in the scheme. Hundred and sixty nine (77.6%) grew maize, 109(50%) potatoes while 95(43.5%) grew beans. The potatoes are grown around the highland plateau of the county.

Table 4.19: Type of crops grown

Crop	Frequency	Percent
Maize	169	77.6
Potatoes	109	50.0
Beans	95	43.5

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The study showed that the stable food was maize which has the highest percentage; the second was potatoes and lastly beans. All these were grown for subsistence use and any surplus was sold for income to enable the families acquire other necessities. Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars (R Manyaka, 2015).

4.9 Other Benefits from PELIS

A part from securing food from PELIS, the farmers also immensely gets other benefits that ultimately enhance their livelihood socially, economically and culturally. These included; fuel wood 214 (98.2), grazing 196 (89.9%), source of income 183 (83.9%) and 155 (71.1%) as shown on table 4.19.

Table 4.20: Other Benefits from PELIS

Benefit	Frequency	Percent
Employment	155	71.1
Firewood	214	98.2
Grazing	196	89.9
Source of income	183	83.9

The study observed that besides PELIS providing food security as the main benefit there were other benefits that came along with it to the PELIS farmers. These included; source of fuel wood for majority of the CFA members 214(98.2%). The second most important other benefit it provided was grounds for livestock grazing 196(89.9%) many members of the adjacent communities were also able to get income 183(83.9%) from the sale of the PELIS crops besides provision of employment opportunities too 155(71.1%). All these other benefits were geared towards enhancing the forest adjacent communities' livelihood (table 4.19).

4.10 Perception of PELIS as Plantation Establishment Strategy by Forest Managers.

The table below shows the perception of PELIS by forest managers. All the six forest station managers applauded PELIS as the most appropriate method of plantation establishment 6 (100%). This was due to reasons outlined on table 4.20.

Table 4.21: Take on PELIS by Forest Managers

Comparison	Frequency	Percent
It enhances water absorption and retention for plant use	6	100
It reduces weeds, therefore less competition for nutrients hence increased plantation survival rate	6	100
It keeps away animals which may browse seedlings unlike grassland which is prone to animals and percolation of water is less	6	100
It reduces establishment costs and damage by pests and rodents	6	100
It significantly contributes to backlog reduction hence increased forest cover	6	100
It contributes to food security for the forest adjacent communities	6	100

Two most common methods of plantation establishment are grassland and PELIS. The former, involved establishment of plantations on grassland, without total cultivation but hoeing of planting spots, while the latter involves total cultivation of the area plantation is to be established. From the study all the forest station managers 6(100%) observed that the strategy was positive in that it enhanced plantation hygiene hence less competition for water and nutrients by trees. PELIS strategy also ensured that animals which may browse on young seedlings are kept away. It also helped to reduce the plantation establishment costs as the cost of land preparation and planting are borne by the farmers. Damages caused by pests and diseases were reduced, plantation hygiene ensured trees were not attacked by the pests and diseases. As farmers tended their crops and did fertilization, thus trees also benefited from fertilizers hence faster growth (table 4.20).

4.11 Challenges Encountered by Forest Managers during the PELIS Implementation.

Table 4.21 below depicts the challenges encountered by forest station managers during the implementation of PELIS. The study established the following as the most common challenges; interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba

6(100%). There was also late shamba preparation by farmers 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers 4(66.7%), uprooting of saplings 3(50%), need for close supervision 6(100%) during planting and after and lack of transportation means 3(50%).

Table 4.22: Challenges encountered by forest managers during the PELIS period

Challenges	Frequency	Percentage
Interference of seedlings rooting system during cultivation	5	83.3
Periodical straying of livestock/wild animals in the shambas	6	100
Late shamba preparation hence delayed time of planting	4	66.7
Over pruning of trees by those doing PELIS	4	66.7
Use of agrochemicals	6	100
Transportation of seedlings during planting	3	50
Uprooting of the saplings purportedly to create space for further cultivation	3	50
Supervision of farmers to avoid damage to the planted seedlings	6	100

The study found out that the most common challenges faced by the forest managers during the scheme implementation was interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba hence browsing or trampling on young tree seedlings 6(100%). There was also late shamba preparation by farmers which affected planting time 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers also affect the growth of the trees, uprooting and deliberate disturbance of the rooting system of the young seedling by the PELIS farmers 4(66.7%).This was to enable the farmers to continue cultivating their shambas for a long period. This affected the growth of young trees hence reduced the survival rate.

It was also established that PELIS require close supervision 6(100%) during planting and after to avoid damage to the planted tree seedlings by the PELIS farmers. Lack of transportation means 3(50%), for the seedlings during planting was also observed by the forest station managers as a hindrance to effective planting exercise. Abandonment of one

year established plantations by the PELIS farmers created room for trees competition with weeds for water and nutrients and grazing and browsing by both domestic and wild animals (table 4.13).

V. K . Agyemen, 2003, observed that in traditional taungya system there were many challenges that included, increased incidences of sabotage to tree seedlings by farmers, the farmers had more interest in their agricultural crops than the forest trees and there were many incidences of forest land encroachment. Farmers deliberately killed planted seedlings to extend their tenure over portion of land , since a successful plantation meant the discontinuation of cultivation on allocated plots, girdling of stems, cutting trees above and below ground, debarking and over pruning. Other challenges were; Cleared more land for plantation development than needed for the available seedlings. Failed to weed around tree seedlings , whereby retarding their growth so as to extend land use rights beyond three years. Illegally farmed other areas in forest reserve, degraded or not , which were not allocated for taungya.

Planted food crops that were not compatible with the tree crops leading to reduced tree growth, lack of supervision by forestry officers. Inadequate financing mechanisms, abuse of powers by public officials especially in farm allocation (Agyeman *et al.*, 2003), over pruning of trees, inappropriate use of agrochemicals and encroachments of forest land for farming.

4.12: Challenges Encountered by Farmers during PELIS Implementation

Table 4.22 below brings out the challenges encountered by farmers during PELIS implementation. The findings of the study were; destruction of crops by wild animals 212(97.2%), livestock destruction 201(92.2%), pests and diseases 189(86.7%) and climate change 153(70.2%).

Table 4.23: Challenges Encountered by Farmers during PELIS period

Challenge	Frequency	Percent
Livestock destruction	201	92.2
Destruction of crops by wild animals like monkeys	212	97.2
Pests and diseases	189	86.7
Climate change	153	70.2

The PELIS farmers cited destruction of crops by straying livestock 201(92.2%), wild animals 212(97.2%) graze and browse on crops, infection and attack by pests and diseases on crops 189(86.7%)i.e. maize lethal necrosis disease and maize stalk borer were mentioned as a threat to crops production by farmers. Effects of climate change 153(70.2%) as it happened in 2014 posed a challenge to the farmers as the rainfall was inadequate and erratic. All these could result to great loses by farmers in both crops and livestock production.

Following wanton destruction of Mau forest there is significant change in rainfall patterns and temperatures .Rainfall seasons sets in late for a shorter period compared to previously with prolonged dry spells, temperatures are relatively high hence high rate of everpotranspiration and dehydration on vegetations and animals besides drying up of water bodies. This makes PELIS activities very challenging especially tree establishment (table 4.14). Farmers also indicated that they are being exploited by KFS as they don't get a share from the sale of the various forest products given that the Forest Act 2005 recognizes the CFA as key stakeholders in forest management.

4.13 Other factors influencing forest cover

On forest governance, if there are no proper rules, regulations, policies and code of conducts and ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, floods and prolonged dry spell. High poverty levels will drive the community to go into the forest to draw their livelihood. This will eventually lead to forest destruction and degradation hence forest cover loss and consequently loss of forest related benefits that would otherwise been assured if there was sustainable utilization of forest related resources.

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five reviews the whole study findings summary, conclusions and recommendations based on the study objectives. The study title was the influence of PELIS on forest cover- a case of Uasin Gishu County, Kenya. The study objectives were: to establish the influence of plantation establishment on forest cover, to evaluate the influence of plantations survival rate on forest cover, to determine the influence of cost of plantations establishment on forest cover and finally to assess the influence of livelihood improvement on forest cover.

5.2 Summary of the Study Findings

The study findings were summarized as below:

5.3. Influence of Plantation Establishment on Forest Cover

On the influence of plantation establishment on forest cover, a total of 4130.4 hectares was established with PELIS from 2008-2014. This represented 12.8% forest cover increase of the total planting backlog of 4438 hectares as at 2008 while that without PELIS was 8.4% increase. The study findings showed there was steady increase in plantation established using PELIS while that one without was relatively low. As the farmers were given plots to grow their crops, they too were expected to provide labour for land preparation, pitting, planting and protection of the planted trees.

5.4 Influence of Plantations Survival Rates on Forest Cover

In respect to plantations survival rate on forest cover, the average survival rate of plantations established with PELIS according to the study was (75.1%). The mean survival rate of plantations established without PELIS was 45.2%. The findings showed that as the farmers tended to their crops in form of weeding, fertilization and protection, trees too benefited from the same. Competition for water and nutrients was minimized through complete weeding.

5.5 Influence of Cost of Plantations Establishment on forest Cover

On the influence of plantation establishment costs on forest cover, the study established that plantation establishment with PELIS costs Kshs 39,527 and without PELIS Kshs 50,564. This translates to Kshs 11037 (27.9%) saving for the government. Land preparation, cultivation, planting, weeding and protection are very expensive exercises. And

all these are subsidized by PELIS farmers. Hence the savings can be redirected to other essential activities like plantations pruning.

5.6 Influence of Livelihood Improvement on Forest Cover

With regard to influence of livelihood improvement on forest cover, the study findings showed that the majority of the CFA members 210(96.3%) indicated that their main source of livelihood was farming-PELIS, only 6(2.7%) and 2(0.9%) indicated business and employment respectively. On average the farmers harvested 22 bags, 54 bags and 5 bags of maize, potatoes and beans per acre respectively. The findings also indicated that 169(77.6%) of the PELIS farmers grew maize, 109 (50%) potatoes while 95 (43.5%) grew beans. Many families were able to earn a living from PELIS especially food, fuel wood, employment and grazing

5.7 Conclusions of the Study

Total cultivation for plantation establishment is expensive but gives the largest established plantations area, the highest survival and growth rates. In the absence or inadequate funding or new technologies PELIS remain a viable option for plantations establishment. PELIS benefits both KFS and farmers, though mechanisms to ensure more benefits to farmers should be explored. PELIS plays a very vital role in forestry management as it is a component of participatory forest management which brings on board other key stakeholders like the forest adjacent community in sustainable management of forest resources. There was a significant increase of 12.8% forest cover of the plantations established through PELIS which was 4130.4 hectares from 4438 hectares as at 2008, hence increased forest cover. A well managed PELIS that observes the laid down guidelines can go a long way in contributing towards attainment of a 10% forest cover as a country by the year 2030 as envisaged in vision 2030 and the constitution.

The study established that the mean survival rates for plantations established with PELIS were higher compared to plantations established without PELIS i.e. at 75.1% and 45.2% respectively. This could have been due to reduced competition for water and nutrients as the PELIS farmers weeds both the young trees and their crops besides fertilization that trees benefit too from. As the farmers protect their crops from straying livestock and wild animals trees too benefits.

The cost of plantation establishment with PELIS (Khs 39,527) was reduced by

Kshs.11037 as compared to plantation established without PELIS (Khs 50,564).This reduction translates to 27.9% savings for the government. This could have been possible due to array of activities farmers carry out for free like clearing, cultivation, pitting, planting, weeding and finally protection. However, the government subsidizes the labour costs.

The study also revealed that 210(96.3%) reported that farming -PELIS is their main source of livelihood. On average the PELIS farmers harvested 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre, With 169 (77.6%) growing maize, 109(50.0%) potatoes while 95 (43.5%) grew beans. It can also be deduced that PELIS targeted the poor in the society and the majority grew maize as it is a stable food crop in Kenya.

5.8 Recommendations

The researcher recommends that:

1. Forest adjacent communities should be given incentives or other sources of income like establishment of nature based enterprises e.g apiculture, ecotourism, acquaforestry e.t.c in forest reserves so that they can devote portion of their land for tree planting hence attainment of 10 percent forest cover as internationally recommended.
2. There should be very close supervision of all PELIS activities carried out by the farmers to ensure minimal damage to the established plantations. PELIS guidelines should be adhered to and implemented to the latter (Appendix vii). The Forest Act no. 7 of 2005 provisions on governance should too be enforced. This would enhance plantations survival rates.
3. Multinational companies like Rai Ply, Tim Sales, and Comply among others should be made to supplement government efforts in terms of contributing some funds for hiring labour for plantation establishment programme as they are the major consumers of forest raw materials. This can go a long way in lowering the cost of plantations establishment.

4. There is need for the government (KFS) to fast track the Forest Management and Conservation Bill of 2014 that has a clause on cost-benefit sharing between KFS and the CFAs as the latter feel they are short changed on forest products benefits especially the share from the sale of timber that eventually would enhance their livelihood.

5.9 Suggestions for further Research

The researcher suggests the following areas for further studies:

1. The influence of PELIS on the plantation rotation age.
2. Cost benefits sharing among key stakeholders.
3. Study on increasing spacing in plantation establishment.

5.10 Contribution to the Body of Knowledge

It was observed from the literature reviewed that there was insignificant relation to the influence of PELIS notably; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement to forest cover in Kenya and globally. The literature reviewed failed to show empirical evidence on how PELIS influences forest cover. It is therefore vital to note that this study has brought out the contribution of the scheme towards attainment of the recommended international thresh hold of 10% forest cover of a country's total land area.

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APPENDICES

APPENDIX 1: TRANSMITAL LETTER FOR CFA MEMBERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu County. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly fill in the questionnaire and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX II: QUESTIONNAIRE FOR CFA MEMBERS

SECTION A: Demographic information (tick where applicable)

1. What is your gender? (a) Male (b) Female

2. How old are you? (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45 (e) 46-50 (f) Over 50 years

SECTION B: Livelihood Improvement and Forest Cover

1. What is the main source of your livelihood?

   (a) Farming- PELIS (b) Employment (c) Business

2. Do you own a shamba in the government forest?

   (a) Yes (b) No

   If no, why?...

3. If yes, How many acres?...

4. What do you grow? (a) Maize (b) Potatoes (c) Beans

5. How much yield do you harvest per acre?

   (a) Maize……….. (b) Potatoes……….. (c) Beans…...

6. Do you grow your crops alongside tree seedlings? (a) Yes (b) No

7. What other benefits do you get from PELIS?..

8. What major challenges do you encounter during PELIS period?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………

APPENDIX III: TRANSMITAL LETTER FOR FOREST MANAGERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu county. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly respond to the interview schedule and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX IV: INTERVIEW SCHEDULE FOR FOREST STATION MANAGERS

SECTION A Demographic Information (tick where applicable)

1. How old are you?

   (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45

   (e) 46-50 (f) Over 50 years

2. What is your highest education level?

   (a) Diploma (b) Undergraduate (c) Postgraduate

3. What is your work experience at this station?......................................

SECTION B: Livelihood Improvement and forest cover

1. Do you have a CFA? (a) Yes (b) No
2. How do they participate in PELIS?...

SECTION C: Plantation establishment and forest cover

1What is the total forest area of your station? ……………………………………….

3. What was your planting backlog as at 2008?...
4. What was your planting backlog as at 2014?..
5. How many hectares were established each year with PELIS between 2008-2014 ?.........
6. How many hectares were established each year without PELIS between 2001-2007?.....

SECTION D: Plantations survival rate and forest cover

1.What were the survival rates of the plantations established with PELIS between 2008 and 2014?

(i) 2008……. (ii) 2009……. (iii) 2010…… (iv)2011…..

(v) 2012….. (vi) 2013………….. (vii) 2014…………..

2. What were the survival rates of plantations established without PELIS between 2002-2007?

   (i) 2002…… (ii) 2003… (iii)2004…… (iv)2005…

   (v) 2006…… (vi) 2007……..

SECTION E: Cost of plantation establishment and forest cover

1 What is the cost of establishing one hectare with PELIS?..

2 What is the cost of establishing one hectare without PELIS?.......................................

SECTION F: PELIS Perception and Challenges

1. What is your take on PELIS and Grassland as main methods of increasing forest cover?……………………………………………………………………………………
………………………………………………………………………………………………

2. What are the major challenges you face while implementing PELIS……………………

APPENDIX V: WORK PLAN

ACTIVITY	DURATION
Topic selection	March, 2015
Proposal development	March, 2015
1st correction of research project proposal	March, 2015
1st defense of research project proposal	April, 2015
Research project proposal correction	April, 2015
Pilot-testing of research instruments	April, 2015
Data collection	May, 2015
Data analysis	May, 2015
Preparation of 1st draft of research project report	June, 2015
2nd correction of the project report	June, 2015
Final defense of the research project report	July, 2015
Final correction of research project report	July, 2015
Final submission of the research project report	July, 2015

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APPPENDIX VI: RESEARCH BUDGET

ITEM	COST (KIHS)
Typing and printing	
• Proposal	10,500
• Project	18,000
Transport	10,000
Data analysis services	5,000
Internet/library services	8,000
Miscellaneous	6000
Grand total	**57,500/=**

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APPENDIX VII: RULES AND REGULATIONS FOR IMPLEMENTING PELIS

Section 47(2) h of the Forests Act 2005 stipulates that ‘’a community forest association (CFA) authorized by the director to participate in the management and conservation of a forest or part of such a forest shall have a right to carry out plantation establishment through non-resident cultivation ‘’ among other activities.

The objective of these rules and regulations is to regulate the implementation of the PELIS scheme in forest reserves.

1. Compliance with the Forest Act.

(a). The permit holder must comply with the provisions of the forests Act 2005 and any rules made there under .Should be permit holder or his/her agents or employees commit any breach of the Forest Act or of any rules made there under, he/she will have committed an offence and will render the permit liable to cancellation or any other penalty imposed by the director in accordance with the forest act 2005.

2. Eligibility for cultivation

(a).All cultivators must be residents of areas adjacent to the forest stations and be members of a registered community forest association.

3. Demarcration of plots

a) Forest zonation and mapping will be done to identify the forest areas suitable for cultivation.
b) The individual plots will be demarcated by the area divisional forest officers, be numbered and put on a sketch map.
c) The sketch maps shall be displayed on the station notice boards.
d) A site –specific management plans will be complied for each forest station implementing PELIS.

4. Allocation method

a) Implementation will be through CFA management committees, consisting of representatives of cultivators.
b) A ballot system will be used in all cases during allocation of plots.
c) All participating CFAs must sign an agreement form before cultivation commences
d) All selected cultivators must obtain a permit before cultivation commences.

5. Crops to be crown

a). Only maize, beans (non-climbers), potatoes, carrots, peas, onions Dania, Chilles, amaranths and cabbages shall be planted in PELIS scheme. The service may review the crops to be grown from time to time.

6. Cultivator's obligations

a) The CFA leadership will ensure that none of its members or ants will take any action that will be harmful to the survival of the plated trees.
b) The cultivator shall ensure that he/she and or/his agents will not take any action that will be harmful to the survival of the planted stock. If the survival is low they will participate in either beating up or replanting, whichever is appropriate.
c) Any form of interference with the normal growth of seedlings and trees is prohibited.
d) The CFA, its agents or employees shall give assistance whenever called upon by the service in controlling illegal activities and in preventing or fighting forest fires.
e) No permit holder will be allowed to lease out or sell the allocated plot. Any attempt to lease or sell a plot will lead to the plot being reposed and plot will revert back to the service.

7. Commencement of tree planting and cultivation period

a) Planting of tree seedlings shall be done after one crop season (one year)
b) Cultivation period shall not exceed three years after tree planting. After this period, a permit holder shall vacate his/her plot.
c) Kenya Forest Service will not be obliged to allocate another plot at the expiry of 3 years period.

8. Areas restricted for cultivation

a) Cultivation shall not be allowed within the water catchment areas and slopes exceeding 30%
b) Cultivation shall not be allowed within a minimum of 30 meters on either side of river valleys and wetlands.
c) Cultivation shall not be allowed in firebreaks, roads reserves and natural forest and under plantations over 3 year old.

d) Under no circumstances shall cultivation be re-opened in plantations after expiry of the authorized 3-year period.

9. Tools and equipment for land preparation and use of fire

Hand tools will be sued for land preparation but animals drawn equipment may be used for the initial opening up. Use of tractors and combine harvesters is prohibited.

Use of fire in land preparation is prohibited .If the use of fire is absolutely necessary; the divisional forest officer shall give written authority, after inspection of the area.

10. Payment of shamba rent

All cultivators will pay prevailing annual rental fees for the allocated plot before cultivation commences for that particular year.

11. Erection of temporary structures

No residential structures will be allowed in PELIS scheme areas except in areas with high incidences of game damage. Construction of such structures shall be erected under a written permit from the director who may also issue guidelines on the number of such structures in a forest area.

12. Penalty of abuse of the system

Any cultivator who flouts these conditions will:

a) Lose the right to cultivate in the forest
b) Be liable to prosecution as specified in the forest act
c) Be liable to both (a) and (b) above
d) Loose any crop that may be on the plot to the service

13. Areas to be opened up for cultivation

a) The opening up of any new areas should be commensurate with the planting programme.
b) Any opening shall only be authorized by the divisional forest officer after inspection of the area and consent from the director of KFS
c) Plot demarcation shall be done under the supervision of the divisional forest officer.
d) The plot sizes shall a maximum of one acre and a minimum of ½ acre.

14. Documents to be maintained

Each station shall maintain a shamba register indicating locality, sub-

compartment number, name of cultivator, national identity card number, and receipt number, date of payment and size of plot.

A sketch map of the area under cultivation shall always be maintained, updated and be prominently displayed in the forester's office.

A register of all temporary structures shall be maintained where applicable.

15. The divisional forest officer will be held responsible for any abuse of the system.

NB: The field stations will receive all the 15 conditions but the farmer should be given the first 14 conditions translated into Kiswahili .The 14 conditions will be prominently displayed in the station notice boards.

APPENDIX VIII: DRAFT PELIS CULTIVATION PERMIT

The PELIS cultivation permit is granted to Mr./Mrs./Miss/Ms……………………….

ID NO………………………… Member of …………………………………………………. Community Forest Association of P.O BOX …………………………………………to cultivate plot number……………………………….measuring ………………..hectares for purposes of identification marked in red and numbered accordingly on the sketch plan on this permit in Sub-Compartment Number………………………………….in ……………………….Forest Station for a period of one(1)year, subject to the following terms and conditions.

1. This permit only allows the permit holder to use plot .This permit does not make the permit –holder owner of the plot. The permit -holder has no right to sell, rent, or act as owner of plot in any way.

2. The permit-holder shall plant only annual crops on the plot. The service has a list of approved crops. The permit –holder shall choose his crops from this list and plant only annual crops.
3. The permit-holder shall help the service upon request in
    a. Beating up or replanting, whichever may be appropriate, in cases of low survival of tree seedlings.
    b. Controlling illegal forest activities
    c. Preventing or fighting forest fires and
    d. Any other activity for the benefit of the forest.
4. The permit –holder shall use hand tools to work the plot but animal drawn equipment may be used for the initial opening only.
5. The permit-holder shall not build any structure on the plot, except with written permission of the service.
6. Breaking the terms of this permit is an offence and if that happens, the service may withdraw this permit. A permit-holder who breaks the terms of this permit may be liable to other disciplinary measures.
7. The permit –holder accepts the risk of injury, harm or death from trees, logs, wild animals, game, rivers and streams, and other hazards on the plot and neighboring forest. Whether the injury happens to property, the permit-holder, or another person, the service is not responsible.

8. This permit does not give the permit holder exclusive possession of the plot or any part thereof and does not create not is it intended to create a lease or tenancy in any way whatsoever.

Signed by the Permit holder……………………Counter signed by CFA official……………

Date ………………………   Date……………………………

Name of issuing Officer………………………………………………………………………

Official Stamp …………………………………………….Date………………………

APPENDIX IX: RESEARCH AUTHORIZATION LETTER

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/0581/6469**

Date:
9th November, 2015

Tobias Otieno Achungo
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of plantation establishment and livelihood improvement scheme on forest cover a case study of Uasin Gishu County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Uasin Gishu County** for a period ending **17th July, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Uasin Gishu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Uasin Gishu County.

The County Director of Education
Uasin Gishu County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX X: RESEARCH CLEARANCE PERMIT

THIS IS TO CERTIFY THAT:
MR. TOBIAS OTIENO ACHUNGO
of UNIVERSITY OF NAIROBI, 41-30100
eldoret,has been permitted to conduct
research in *Uasin-Gishu* *County*

on the topic: *INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER A CASE STUDY OF UASIN GISHU COUNTY KENYA*

for the period ending:
17th July,2016

Permit No : NACOSTI/P/15/0581/6469
Date Of Issue : 9th November,2015
Fee Recieved :Ksh 1,000

....
Applicant's Signature

....
for *Director General*
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 7122

CONDITIONS: see back page

INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER: A CASE OF UASIN GISHU COUNTY, KENYA

BY

TOBIAS OTIENO ACHUNGO

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT

UNIVERSITY OF NAIROBI

2015

DECLARATION

This research project report is my original work and has not been presented for a degree in any other university.

Sign________________ Date ________________

TOBIAS OTIENO ACHUNGO

L50/71180/2014

This research project report has been submitted for affirmation with my approval as university supervisor.

Sign____________________ Date________________

KORINGÚRA JULIUS

Lecturer Department of Extra Mural Studies

School of Continuing and Distance Education

University of Nairobi

DEDICATION

This research project report is dedicated to my family for their unwavering support, prayers a nd patience during the entire preparation period.

ACKNOWLEDGEMENT

I wish to register my sincere appreciation to my supervisor Koring'ura Julius for finding time out of his busy schedule to guide me through the preparation of this research project report. It is with humility that I register my gratitude to my lecturers; Dr Paul Odundo, Dr Anne Assey, Mr. Sakaja, Mr.Patrick Cheben, Mr. Ochieng Owuor and Mr Peter Lukhuyani, for taking me through the various courses that were relevant to this study. I would also wish to thank my employer, Kenya Forest Service for granting me an opportunity through a course approval to sharpen my skills, knowledge and experience to enhance my performance. I also recognize the immense support from fellow students during the course and project write up. I salute the University of Nairobi for providing an enabling environment to help me reach this far. My heartfelt gratitude also goes to my family once more for their patience, support and prayers during the study. And finally I thank Mss Gladys for taking her time to do typesetting and formatting this research project report.

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LIST OF ABBREVIATIONS

AFCN	African Forest Conference Network
CFA	Community Forest Association
FAO	Food and Agriculture Organization
FC	Forestry Commission
FD	Forest Department
FRA	Forest Resource Assessment
FR	Forest Reserve.
FRIN	Forestry Research Institute of Nigeria
FSD	Forest Services Division
IGA	Income Generating Activities.
KFS	Kenya Forest Service
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MFW	Ministry of Forestry and Wildlife
MMMB	Miti Mingi Maisha Bora
MTS	Modified Taungya System
NACFA	National Alliance for Community Forest Association
NEMA	National Environment and Management Authority
NP	National Park.
PELIS	Plantation Establishment and Livelihood Improvement Scheme
PFM	Participatory Forest management
REDD+	Reduction in Emissions from Deforestation and Degradation
REMA	Rwanda Environmental and Management Authority
UNEP	United Nations Environmental Programme
WB	World Bank

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ABSTRACT

There has been increasing rate of forest destruction and consequently decline in forest resources in Kenya due to the high rate of increase in human population, thus exerting pressure on natural resources. The decline has been attributed to factors such as deforestation, commercial agriculture, urbanization, pastoralism, charcoal production, forest cultivation, illegal logging, forest fires and replacement of indigenous forests with exotic plantations. Decline in forest resource has been further exacerbated by increasing poverty levels and the community perspective of forest as public good in addition to changing global forest trends. It is on this back drop in forest cover levels that the government of Kenya through Kenya Forest Service modified "shamba system" to PELIS which for a long time has been used by the government of Kenya to raise forest plantations where the forest adjustment communities benefits from cultivation of crops in the forest and KFS benefits from forest plantation establishment at low costs. The key objectives were; to establish the influence of plantation establishment on forest cover, to determine the influence of plantation survival rate on forest cover, to investigate the influence of cost of plantation establishment on forest cover and to assess the influence of livelihood improvement on forest cover. Therefore this study aimed at establishing the influence of PELIS as a strategy to increase forest cover. The study was informed by the theories of Environmental Kuznets Curve and forest transition, which affirms that a U shaped relationship exists between environmental quality and economic development and also contends that forest cover, is an indicator of environmental quality and income levels. Survey research design was used. The study targeted a population of 6521 including 6 forest station managers and 6515 CFA members. Stratified, purposive and simple random sampling methods were used to select forest stations and CFA members for the study. Structured questionnaires, interview schedules and personal observations were used to collect primary data besides use of secondary data from the offices. Descriptive statistics such as means, tables, percentages and frequencies were used. The findings of the study provided an insight on the contribution of PELIS in increasing forest cover. The study established that PELIS contributed to 12.8 % increase of forest cover. The results clearly showed that the survival rates were higher in plantations established with PELIS than those established without PELIS by an average of 75.1% and 45.2% respectively. On the cost of plantation establishment, it was established that the cost was Khs 39,527 with PELIS while without PELIS was Kshs 50,564 representing 27.9% savings. The study also confirmed that there was livelihood improvement as PELIS farmers harvested an average of 22 bags, 54 bags and 5 bags of maize, potatoes and beans respectively. The study also established that 96.3% of CFA members dependent on farming-PELIS as a source of livelihood. It was recommended that there is need to give forest adjacent communities alternative sources of livelihood as incentives so that they could allocate a portion of their land for tree growing, there should also be closer supervision of all PELIS activities to reduce damage to young plantations. Multinational companies should supplement government efforts through provision of funds for reforestation and government should fast track forest management and conservation bill that provides for benefit sharing.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The world's forest, cover some 3500 million hectares, of which 57% of these are located in developing countries mostly in the tropics, worldwide about 1.6 billion people rely heavily on forest resources for their livelihood and estimated 400 million are directly depended on forest resources. Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. It is estimated that the rate of global forest loss has hit 13 million hectares per annum in the last decade (2000-2010) (FAO, 2010). The world looses 7.3 million hectares of forests a year, about four times the size of all gazetted forests in Kenya. Due to extensive reforestation, this new forest shrinkage has slowed slightly from the 8.9 million hectares lost in the 1990s. Despite the decrease, deforestation has not declined significantly since 2000 (KFS, 2014). Globally tropical forests are being reduced at the rate of about 7.5million hectares of closed forest and 3.8million hectares of open forest annually (Lenely, 1982). The global net rate of change in forest cover for normal tropics is estimated to be 23% (Arched *et al*, 2002) signifying a high reduction rate of forest covers.

Closer home, Africa has lost 64 million hectares of forest between 1995 and 2005, the greates decline on any continent during the same period. Fuel wood gathering drives much of the forest depletion. Timber exports also play a role, with 80% of the Congo basin’s timber production being exported, mainly to China and European Union. Much of the world’s wood is harvested illegally. Illegal logging accounts for more than half of timber production in Russia, Brazil and Cameroon. In addition to devastating forest ecosystems, illegal logging robs forest dwellers of their livelihoods, fuels social turmoil, and deprives timber producing countries of up to ksh. 1.14 Trillion of revenue annually (KFS, 2014).

In the case of Africa, even though most tropical African countries had considerable forest cover at the beginning of the 20th century that ensured environmental stability, the need to increase food production, high demand for wood products and rapid increase in infrastructural development to satisfy growing population has resulted in rapid increase in deforestation and forest degradation (Forestry Commission, 2011). KFS, 2014 observed that forest cover loss leads to; increased occurrence of floods, reduced recharge of ground water, decreased water volume in rivers during dry seasons, sometimes rivers dry up, increased drought periods from an average 2 year cycle to 4 year cycle, increased sediment loads in

rivers, lakes and oceans, changing rainfall patterns, soil desiccation, inadequate timber and fuel wood, loss of bio diversity and intrinsic value of forests amongst others. All these are as a result of climate change.

FAO (2010) observes that, over the last century for example, forest cover in the African region has been under intense pressure from human activities in the name of livelihood sustainability and development. This perhaps explains why Africa now has the second highest rate of deforestation worldwide with 3.4 million hectares of forest loss per annum. Thus the need to seek remedial measures through community, national and global initiatives such as Reducing Emissions through Deforestation and forest Degradation (REDD+) has been well received by many policy makers and governments towards environmental sustainability and green development, as enshrined in the goal seven of the Millennium Development Goals (Karsenty *et al*., 2012). However, the expense of forest areas is declining across the globe partly as a result of logging activities and also due to conversion of habitat to crop land, agricultural expansion accounts for up to 43% of tropical forest losses (MEA, 2005).

This has led to the recognition of the need to include the communities living close to forests through CFAs in management of forest resources to reduce this rate of forest loss. Only 32.5million hectares of African forest and woodlands or 5% of the total forest area are formally protected. The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in western, central and eastern Africa where there in considerable forest cover (UNEP, 2005).

Africa and South America distinguish themselves by showing distinct decline in forest cover. For Africa the direction for the past twenty years is clear even though the rate of deforestation seem to have declined over the last few years. However, forest cover alone does not tell us what kind of forests we have , what benefits they might provide, how well they are managed or if they are degenerated (FAO, 2010). In the Lake Victoria basin problems among other things such as soil erosion and declining soil fertility have been attributed to loss of forest cover (World Agroforestry Centre, 2006). The land was formerly rich in natural forests but this resource has been severely over exploited. Deforestation combined with unsustainable agricultural methods has resulted in widespread, increasingly conspicuous land degradation (Maitima *et al*., 2010). As a result of the above, there is need to stop further deforestation through conventional strategy to save biodiversity for the survival of human

kind.

According to MMA (2008), Africa has high per capita forest cover of 0.8 hectares per person compared to 0.6 hectares globally. On average forests account for 6% of GDP in Africa which is the highest in the world. In Uganda for example forests and woodlands are now recognized as an important component of the nations stock of economic assets and contribute in excess of US $54.6 million to the economy through forestry, tourism, agriculture and energy. The state of Rwanda's forests and woodlands and their importance to the national economy is also well documented. Forests are designated as protected areas which host game parks and forest resources and make contributions to the national economy by supplying renewable sources of energy in the form of wood fuel and charcoal. They also make an indirect contribution to sustainable agriculture and are sources of medicine, fodder, honey, essential oils as well as handcrafts and construction materials. However, they are also threatened by mining, fires and poaching (REMA, 2009).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. FAO, 2013 noted that there has been a straight line decrease in forest cover in Kenya between 1990 and 2012 ie 1990 37,080km^2, 2000 35,820km^2 and 2012 34,450 km^2. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

Muthike (2004) notes that forests plays a vital role in water catchment protection, climate change mitigation, agricultural production, hydroelectric power generation, habitat for wildlife, ecotourism, food, employment, income, research and education among others. In addition over 1 million households, living within a radius of five kilometers from the forest reserves depends on the forests for cultivation, grazing, fishing, food, fuel wood, honey, herbal medicine, construction materials, water and other benefits (KFS, 2012). Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

Despite all these importance, the forests are under tremendous pressure from growing population and therefore innovative strategies are required to support their sustainable management (KFS, 2012). Forest cover in Kenya has been decreasing over the years and the main drivers have been poor legislative frame work and governance, politics, encroachment, illegal cultivation, illegal logging, charcoal burning, excision, poverty, population pressure, industrialization and poor understanding of the benefits of forests by the local communities.
World Bank (2007) observes that sawn timber remains highly valued and in short supply in Kenya for a number of reasons. One is that the land available for forest is diminishing in medium to high potential again ecological zones. Forests in such places face direct competition from land for agriculture, infrastructure and urban development estimated at 5,000 excerbarated by an increasing population on limited available land is dramatically reducing forest acreage. The enactment of the Forest Act 2005 as admittedly helped to revitalize the section by giving local communities a stake in the management of state and county forests.

As in many countries, Kenya official status do not accurately reflect the extend of forest resources as a contributing factor to the economy. These gaps fuel the perception that forests meet substitutes needs only and is therefore not important. Data for the period 1989-2005 indicate little change in forest cover yet known existence suggest the figure for gazetted forests should be lower. Conversely extensive tree planting which took place under the afforestation and extension scheme on private land and state forests and in some forests managed by local authorities should show higher forest cover in these areas. It is therefore recommended that a participatory approach to formulating and implementing forest policies is adopted in order to ensure local communities support (KFS, 2014).

1.2 The Concept of Taungya System

1.2.1 Taungya System in Thailand

In Thailand, a country that neighbours Burma, the destruction of forest through shifting cultivation was a serious problem. More than 10,000 hectares of forest lands were denuded annually by hill tribes and other farmers . Forest village scheme was introduced by the government and Forestry Organization as an attempt to stop further spread of shifting cultivation and deforestation. The forest village system offered hill tribesmen and others who practiced slash and burn agriculture considerable inducements to settle down. One of principle aims of the scheme was to keep a steady labour force on

hand for long term needs of forestry, while at same time providing rural families with income and other benefits from the kind of farming they choose to practice (S A O Chamshama *et al.,*1992).

The underlying principle of the scheme was to link reforestation with social welfare of the people involved. A systematic programme of public information and the involvement of community leaders were necessary to gain public acceptance of forest villagers before they could be started in the FVS, the families were allowed to grow crops during the first three years of establishment. The families were also provided with free agricultural advice, primary education and medical services. Families who agreed to give up shifting cultivation for settled land use were given tenure of a plot of land to construct a house and develop a home garden, where crops could be grown and few animals reared. In return the farmers were required to help establish and maintain forest plantations. (S A O Chamshama *et al*.,1992).

Although the scheme rain well below targets, opportunities had been provided for people to settle, with long term employment prospects and affording a higher standards of living than previously. The families had abandoned shifting cultivation thus reducing pressure on native forests. Also, through forest villages biodiversity had been improved. Not with standing numerous weaknesses and constraints of the scheme were identified, which included setting up of villages with promised facilities required significant expenditure, there was scarcity of capable managers to oversee the village functions, where forest was still plentiful, ensuring adherence to forest village policy was difficult, and so illegal shifting cultivation continued ; some sites were on steep slopes with poor soil, thus cultivating crops was hard and yields were low, cash flow problems arose as payment as payment of bonus were not made until the end of the first year of participation. Furthermore, financial incentives were too low for some ,resulting in their leaving to seek work elsewhere (S A O Chamshama *et al*.,1992).

1.2.2 Taungya System in Uganda

In Uganda, taungya has been practiced for many years. Uganda admits taungya to be a good practice of carried out properly like it was done in Burma. By planting trees with food crops weed invasion was prevented and soil cover was retained and through taungya there was a maximum use of land as both crops and trees were grown. Also employment was provided over a large scale.(tree growers and crop growers are all

employed) and there was cheaper forest establishment and protection and whose legummous crops were grown, the nitrogen benefited the trees, yet and certainly most important, taungya system promoted food security. However, over the past 30 years or so, the results of taungya have been disastrous in terms of establishment of tree plantations. Farmers faced with possibility of becoming landless, once the trees are fully established often damaged or killed the trees (S A O Chamshama *et al.*,1992).

In some parts of Uganda , farmers severely pruned the trees branches to prevent them from shading their crops, whereby extending the period they can use the land for their crops. In some instances, farmers physically uprooted the trees (or partially uprooted to severe some of the roots) to further extend the period they can grow their crops, some instances of heaping weeds on top of saplings had also been recorded. Furthermore, the farmers planted unacceptable crops such as planting tall crops, like maize and sorghum, which soon overtopped the trees so weakening and killing them, several crops species are known to be controversial and are excluded in forest plantations in some countries, such crops include bananas and plantains. (Musa spp), Cassavas (*Manihot utilissima*) and sugar cane *Sacharum officinarum*). Sugar cane for example, is generally extended because it is a long growing crop, so it is feared to deplete the soil and because it casts a heavy shade, Also it is known that allelepathic effects exists in which sugar cane suppresses the growth of trees seedlings (S A O Chamshama *et al.*,1992).

Most Taungya problems in Uganda were reported to have been caused by luck of adequate supervision. To redress the situation and to ensure equitable access to forest resources, the government of Uganda formulated policies and laws to ensure that communities, especially vulnerable ones participated in decisions that affect their livelihoods. One such policy was that of collaborative forest management (CFM). CFM is an approach that enhances community participation and development of partnerships for Forest management. In areas where CFM is implemented that is better enforcement of forest rules (D .A. Ndomba *et al.*, 2014)

1.2.3 Taungya System in Ghana

In Ghana about 75 percent of her forest plantations were established using taungya system in the earliest version of taungya that was launched in Ghana in 1930, the farmers had no rights to benefits accruing from the planted trees. Also, the farmers had no decision making role in any aspect of forest management. A s as a result , the farmers

tended to neglect the tree crops since they would not directly benefit when it matured. The farmers also realized that if the tree canopy closed, they would be asked to stop farming to enable the establishment of the tree crop from which they would not benefit. Consequently, most farmers deliberately killed the trees so that they would not be asked to stop farming. Other evils committed by the farmers included clearing more land for plantation development than was needed for available seedlings. They failed to weed around the seedlings , there by retarding their growth so as to extend land use rights beyond three years; the farmers also illegally farmed other areas of the forest reserved whether degraded or not (S A O Chamshama *et al*.,1992).

Furthermore, the farmers planted food crops most were not compatible with the tree crops leading to reduced tree growth. Other problems included lack of supervision by the forestry department; inadequate financing mechanisms and abuse of power by public officials, especially in farm allocations. As a result, the system was suspended in 1984. Following these observation the taungya system in Ghana was revised in 2002 to make itself financing and sustainable and partly to provide employment and alleviate poverty in the rural communities. (S A O Chamshama *at el*.,1992). In the new version, the farmers became owners of forest plantation products while (FC) and forest adjacent communities were shareholders. The farmers provided labour, did pruning and maintenance and tending of forest plantings; the Forest Commission provided technical expertise, farmers training, provision of equipment and tools , stock inventory and marketing of forest products; the land owners contributed land while the forest adjacent communities provided the services of protecting the investment from fire.

The consultation process devised an equitable benefits sharing frame work based on Contribution of the participants. These levels of contribution together with stakeholder expectations led to the following benefits sharing framework; The farmers get 40% of Timber benefits; the forest communities gets 40% , the land owners get 15% while Forest adjacent communities get 5% of the benefits accruing from the Modified Taungya System (MTS). This was to ensure sustainable system and continuous flow of benefits to participating farmers after harvest of food crops at the end of third year and there should be some bulk payment at the time of harvesting logs. (O. A Ndomba *et al*., 2014)

1.2.4 Taungya System in Kenya

In Kenya, Taungya system was adopted in 1910 and was referred to as shamba

System. First introduced as a modified form of the taungya used in south East Asia; the shamba system was a method, of forest plantation established in which farmers tend tree saplings on state owned forest land in return for being permitted to intercrop food crops until canopy closure. The shamba system significantly reduced the cost of forest establishment as weeding costs were borne by the farmers. The system also provided significant benefits to farmers in the form of food.

In 1990s the shamba system was often abused and young trees were often neglected or deliberately cut to enable cultivation to continue beyond the usual three years period. These actions slowed down reforestation progress and resulted in vast areas of land under cultivation within forest reserves. Following these mishaps the system was banned by presidential decree in 1987, and in the following year all forest residents were evicted from forest areas. The shamba system was subsequently replaced by

A modified system referred to as Non- Residential Cultivation (NRC). In the NRC, farmers were Integrated into the Forest Department (FD) as resident workers. Under NRC the farmers were allocated plots , still by the name ,shambas' but with guaranteed work for nine months per year. The produce from the shambas was considered part of workers emolument as they tended the young trees. This NRC too was banned after a few years and was being replaced with a redesigned system referred to as the Plantations Establishment and Livelihood Improvement Scheme (PELIS). The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation (O.A. Ndomba *et al.;* 2014).

1.2.5 Justification for Plantation Establishment and Livelihood Improvement Scheme (PELIS)

PELIS involves farmers planting and tending the saplings on a state owned forests in r eturn for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years). Before being allowed to cultivate in the forest they sign a PELIS cultivation permit where they commit themselves to abide by the rules and regulations that govern the scheme (Appendix vii). The scheme is meant to improve the economic gains of participating farmers while ensuring success for planted tree (AFCD, 2012).

In mid 2007, acting in conformity with the Forest Act 2005, the Kenya Forest Service (KFS) in collaboration with key sector partners particularly forest adjacent communities revis ited the pros and cons of Non –Residential Cultivation (NRC). KFS outlined a new model, re-branded as the Plantation Establishment and Livelihood Improvement (PELIS).

The overall objective of PELIS was to establish forest plantations and improve the livelihoods of communities through sustainable collaborative management of gazette forests. The PELIS initiative was to have the following other objectives.

1) To reduce the cost of plantation establishment that currently stands at Kshs.25.000 per hectare at three years using the pitting and spot weeding method as compared to about Kshs.10,000 per hectares under shamba system (by 2007).

2) To improve the rate of growth of the planted stock as would be the case under complete cultivation as compared to pitting and spot weeding method.
3) To allow the people leaving next to forest reserves improve their food security and incomes through raising of crops together with trees in forest reserves and hence change their attitudes to forest conservation.
4) To reduce and eventually eliminate replanting backlogs that currently stands at 16,000 hectares.
5) To minimize the need to seek assistance in plantation establishment from forest based industrial companies.
6) To minimize the need for KFS to hire labour for plantation establishment.
7) To achieve sustainability in harvesting and replanting of plantations. (KFS, 2007)

1.3 Statement of the Problem

Environmental concern including deforestation and forest degradation, climate change and environment based livelihood insecurity continue to receive global attention. Forest underpin important sectors of the economy including agriculture, tourism, energy, water and manufacturing among others. Further 80% of the population depends on wood as the primary source of energy.

Kenyans population is on the rise and stood at 38.6milion in 2008 and at the 2.9% growth rate. The resulting high demand for forest and woodland products by arising population created led to conflicts and environmental degradation as forest are cleared to make way for human settlement and agriculture, industrialization, frequent drought in Narok,

for instance are attributed to the rapid growth of settlement and the increased rate of deforestation by conversion of burning and illegal logging upstream in the Mau forest.

It was on this background of the myriad products and services that forests provide to human kind and other flora and fauna. Hence it was important to check on the growing negative effects of climate change that is aggravated by the continued deforestation with the key driver being human induced activities. PELIS as strategy is capable to reverse the trend if well managed and the rules and regulations governing the scheme are observed to the latter.

1.4 Purpose of the study

The purpose of the study was to establish the influence of Plantation Establishment and Livelihood Improvement Scheme (PELIS) on forest cover.

1.4.0 Research Objectives

1.4.1 Objectives of the Study

1. To establish the influence of plantation establishment on forest cover.

2. To determine the influence of plantation survival rate on forest cover.

3. To investigate the influence of cost of plantation establishment on forest cover.

4. To assess the influence of livelihood improvement on forest cover.

1.5 Research Questions

1. How does plantation establishment influence forest cover?

2. How do plantation survival rates influence forest cover?

3. How does the cost of plantation establishment influence forest cover?

4. How does livelihood improvement influence forest cover?

1.6 Significance of the Study

The continued degradation of forests resources calls for concerted efforts by the policy makers and researchers to slow or stop the loss of forest cover. The findings of the study will help the policy makers in the industry to know the level of success or failures of PELIS and make the necessary adjustments if need be. The researcher will be able to fill the

knowledge gap in terms of the role of PELIS in increasing forest cover. The government will also be able to appreciate the role of PELIS in terms of bridging the gap on food insecurity.

KFS as a key player will be able to determine whether it is working towards achievement of 10% forest cover as envisaged in the constitution and the internationally recommended thresh hold. The study will also influence level of participation of donors in the sector by having confidence and continue funding if the forest cover level increases. Positive results will gear the country towards economic development by improving the key sectors of the economy like industries, agriculture, energy and tourism that largely depend on sustainable management of forest resources.

1.7 Basic Assumptions

The study assumed that all the six forest stations under the study are practicing PELIS and by extension have Community Forest Associations (CFAs). The planting backlogs have substantially been reduced. The researcher assumed that the respondents will cooperate and give honest response to the questions in research tools. It was also assumed that the sample size chosen was adequate to enable the researcher draw valid conclusions on the study.

1.8 Limitations of the Study

In the course of the study it was difficult to obtain the updated information on the plantation records. The CFAs also provided varied information on food production through PELIS, this was overcome through verification of secondary data with field data, interviews and personal observations. Weather, difficult terrain and vast areas of some forest estates also posed some challenges during data collection in the field this was lessened by visiting the field early in the day and putting on the right attire. Language barrier was also a challenge and was minimized through an interpreter. The study used structured questionnaires, secondary data and interview schedule as data collection tools besides personal observations.

1.9 Delimitations of the study

The study covered the six forest stations in Uasin Gishu County. As anything more than this could not be viable given the time limit and resources available especially funds. Given that NRC was modified to PELIS in 2007 and its implementation started in 2008 in selected stations in the country. The study covered plantations established 2001-2014.

1.10 Definition of Terms

Plantation Establishment and Livelihood Improvement Scheme

PELIS involves farmers planting and tending the saplings on a state owned forests in return for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years) (AFCD, 2012).

Plantation Establishment	It encompasses species selection, site clearing, staking out, pitting and planting of the tree seedlings in the field.
Forest cover	It is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production system (for example in fruit plantations and agro forestry systems) and trees in urban parks and gardens (FAO, WB, 2015) It is an area more than 1 ha in extent and having tree canopy density of 10% and above.
Livelihood	It is a means of making a living. It encompasses people's capabilities, assets (including both material and social resources), income and activities required to secure the necessities of life.
Livelihood improvement	This is when livelihood is sustainable and it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conways,1991).
Planting Backlog	These are un stocked areas that were either clear felled or opened up for PELIS but have not been planted.
Survival Rate	It is the percentage of saplings surviving after six months of establishment in their natural environment.
Sapling	A young tree, especially one not over 10cm in diameter at breast height.
Acquaforestry	It is the science of raising acquatic animals and trees.
Apiculture	It is the management and study of honey bees.
Taungya	It is a Burmas word meaning hill cultivation; it was introduced

in India in 1 890. It is a modified form of shifting cultivation in which labour is permitted to raise crop in an area but only side by side with the forest species planted by them.The practice consist of land preparation, tree planting, growing agricultural crops for 1 – 3 years until shade becomes dense and then moving on to repeat the cycle in different areas

1.11 Organization of the Study

Chapter one represents background of the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study. It also entailed delimitations of the study and definition of terms as used in the study. Chapter two covers review of related literature on plantations establishment, plantations survival rate, costs of plantations establishment and livelihood improvement on forest cover. Theoretical and conceptual frameworks and gaps in literature review were also highlighted.

Chapter three described research methodology, which included research design, target population, sample size and sampling techniques, research instruments, pilot testing and data collection procedures, data analysis and ethical considerations. Chapter four gives detailed analysis, presentation, interpretations and discussions of the study findings while chapter five reviews the whole study summary, conclusions and recommendations based on the study findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter looks at both theoretical and empirical literature related to plantations establishment and livelihood improvement scheme (PELIS) and its influence on forest cover. The chapter also reviews the independent variables in relation to the dependent variable. It also identifies knowledge gaps that are as a result of analyzing the theoretical and empirical literature.

2.2 The Concept of Forest Cover

Deforestation in all of the Kenyans five water towers is mainly due to poor environmental governance. This consequently include loss of forests cover, increased soil erosion, drying or rivers and stream, siltation in dams and increased cost of forest related products such as timber (NEMA, 2005). Forest and woodlands are particularly vulnerable to climate change. This is because the impact of climate change and variability led to change in land cover and land use, increased incidences of pests, diseases and fire outbreaks and foment loss of livelihoods (Ogwang *et al*, 2010). Apart from offering oxygen, fuel and building materials, trees store important quantities of carbon , which if released, contribute to global warming (FRA, 2015). Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water resources which loses its quality as forests condition worsens (MEA, 2005).

Over 80% of Kenyans rely on wood biomass for their energy requirements, which exerts considerable pressure on the tree and forest resources. In addition, the wood conversion technologies for timber manufacturing and charcoal production are obsolete and wasteful leading to overharvesting of trees to meet the demand. Globally and nationally the climate is changing, and this is having a direct impact on forest resources and ecosystems and on people and their livelihoods flooding, landslides and drought. Forestry can play an important role in both mitigation and adaptation to climate change, and towards green growth. Forest plantations supply industrial wood and also play a crucial role in conserving biodiversity, providing habitat for wildlife, conserving soils and regulating soils and regulating water supplies and sequestering carbon dioxide, they also reduce pressure on the indigenous forests (Forest policy, 2015).

Of late weather patterns have changed in the county especially rainy seasons comes late, the rains are erratic, prolonged and intense droughts coupled with drying up of rivers and springs. The price of forest products have also been ballooning due to acute scarcity. It is therefore on this background that the study explored the influence of PELIS in increasing forest cover in state forest areas to mitigate on the above mentioned challenges. Demand for sawn timber, furniture, timber packaging and less end use is increasing as building construction is expanding and standard of building is improving. Consumption in 2010 is estimated at 855,000m3 consisting of Kenya production of 760,000m3 and imports of 95,000m3, (MMMB, 2013).

Kenya has 3.45 million hectares of forest cover which is equivalent to 6.9% of its land area. Kenya is classified as a low forest cover country. Out of these 1.41 million hectares or 2.4% of the total land area comprises of indigenous closed canopy forests, mangroves and plantations in both public and private lands (KFS, 2012). This does not meet the internationally recommended threshold of 10% of country forest cover. On average 5,000 hectares of forest cover are lost every year through illegal logging, encroachment, excisions for settlement and cultivation (GOK, 2010) again an estimated 3000 hectares of state forests are lost to fires annually. The fires are either spread accidentally from neighboring private farms or are started deliberately as an act of sabotage.

MFW,2013 observed that forests in Kenya including plantations are important in conservation of biological diversity, regulation of water supplies; carbon dioxide sequestering and are major habitats for wildlife which promotes tourism. Forest conserves water catchment areas. They also provide water to support irrigation schemes that are important for agricultural sector development (ICFW, 2013). M Nichlon, 2000 observed the role of native forest as to restore ecosystem services like water quality, water provision, air quality, soil quality, soil conservation among others. Kakamega, Kenya (Thomson Riveters Foundation). A Kenyan government plan to increase forest cover by giving local people incentives to plant and preserve trees is paying off, resulting in more productive farmers and a landscape better able to cope with the changing climate.

2.3 Policy and Legislation to Improve Forest Cover

Kenya’s forest cover is disappearing at an alarming rate. According to sessional paper No.1 of 2007 on forest policy; our forest cover was less than 2% of the total land area as opposed to internationally recommended standards of at least 10%. Lack of adequate

budgetary allocation by the treasury and staff shortage made it necessary to involve the community in a forestation exercise. The PELIS strategy was expected to deliver benefits of increasing the forest cover by involving the forest adjacent communities who were directly affected by both positive and negative activities in the forest.

The forestry sector has been characterized by ineffective regulatory mechanisms and inadequate law enforcement. The Forest Act no. 7 of 2005 that became effective in 2007 was a milestone in forest governance and brought about Community Forest Association participation in plantation establishment through non resident cultivation and protection of the forest resource (Forest Act no. 7 of 2005). Further the promulgation of the of the constitution brought new requirements for natural resource management such as public participation, equity in benefit sharing, devolution and the need to achieve 10% forest cover among others (Constitution of Kenya 2010; Vision 2030, 2008). These challenges are compounded by dwindling public land, which need incentives and clear methods of engagement to encourage investments in commercial forestry on private land. The policy statement is to promote private sector participation in establishment and management of plantations through appropriate forest management arrangements and incentives and promote species diversification through planting of indigenous and exotic species with proven potentials (Forest policy, 2015).

Over the last few decades, policy makers have advocated and applied forestry decentralization as an appropriate means of environment protection and sustainability. (Anderson, 2006).This has often been done with the motivation to increase the involvement of forest based communities and local institutions in forest resource management. Their assumption is that the local people’s involvement in forest resource governance is the most appropriate means of ensuring sustainable forest resource management and green development (Robert and Larson, 2005, Ribot and Oyoro, 2006). In pursuit of its commitment to reverse the degradation of forest for examples, the government of Ghana, in 1996, launched the forestry and wildlife master plan to reverse deforestation between 1996 and 2020 which is estimated at 65,000 ha per annum (Forestry Commission, 2001).

Against this background, the forestry sector in Ghana has implemented a number of decentralized schemes (Marfo, 2004). One of them for which the issue of livelihood development and forest reclamation are so crucial is the modified Taungya system (MTS). In 2001 the government Ghana launched the MTS as a decentralized mechanism to halt and reverse degradation of forest resources as well as build community resilience for enhanced

rural livelihoods and poverty reduction. The MTS is a decentralized forest management strategy in which communities are given portions of degraded forest reserve to inter-plant food crops with trees and further nurture trees into maturity under an agreement in which costs and benefits sharing are specified .In this arrangement the forestry commission of Ghana transfers responsibilities to selected forest fringe community members and established local authorities as partners both in managing and drawing benefit from forest reserve to ensure local communities commitment to sustainable forest governance. After over a decade of the MTS, implementation its viability to achieve or deliver livelihood security, forest resource recovery and poverty reduction at the local arena require monitoring and verification (Prince Osei *et al.*,2008).

The Modified Taungya System (MTS) involves the establishment of plantations by the government (FC) in partnership with farmers. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The farmers are allowed to cultivate food crops which are planted between the trees on the same lands. As the farmers does all the labour while not getting paid for it. They will have a share in the future timber revenue. They are entitled to 40%, whereas the government also gets 40% and the land owner and community will obtain 15% and 5% respectively. Many farmers in the MTS are migrant farmers; they go back after 2 years. So the plantations are abandoned, which is not good for the trees as they need to be maintained. It is better for the plantations that the stay for a longer time. The original Taungya system was modified and extended with the benefit sharing scheme because the scheme was boycotted by the farmers due to lack of benefits and voice (Interview Zonal plantation managers of the FC, 2010). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

In recognition of the important role that increased forest cover and food security plays coupled with the challenge of inadequate funding towards forest plantation establishment. The government of Kenya through (KFS) modified "shamba" system which for a long time has been used to raise forest plantations where the forest adjacent communities through

(CFA) benefit from cultivation of food crops in the forest during the early stages of forest plantations establishment of forest plantation at a low cost (Mwatika *et al.*, 2013). Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced as a policy guideline to address the decreasing trend of forest cover. The scheme has been used to establish forest plantations since 2007.

A review of the past studies on the shamba system shows that success and failures depends on how well government guidelines are implemented and enforced when the system was reorganised in 2000, success rates climbed and again recede after the 2003 ban. Funds allocated to the FD for forest operations are grossly inadequate declining from kshs 390 million in 1996 to 95 million in 2004. Though planting has increased, fewer seedlings are surviving, rates have declined from as high as 90% to as low as 10% in some stations (Kagombe *et al.,* 2005).

Since 1968, the country has experienced a major decrease in forest cover which has resulted in reduced water levels, bio diversity, supply of forest products and habitats for wildlife. Also according to sessional paper No 1 of 2007 on forestry policy, the forest sector has been faced with conflicts between forest managers and forest adjacent communities over access to forest resources. In response to increasing back logs and adequate resource capacity within the forest department to reestablish plantations, the shamba system was reorganized and reintroduced in a few districts as NRC in 1994.

2.4 Plantations Establishment and Forest Cover.

Nair (1985) indicates that, in case of severe deforestation, programmes are important to restore the tree cover. When plantations are established, they can provide a sustainable tree cover, but working at the biodiversity and environmental services compared natural forests, the plantations are poor in supplying them. Forest plantations have more potential to grow food crops, as the space between the trees can be used to grow food crops during the first years of plantation establishment. This could be beneficial for people who live and work in forest plantations. So plantation establishment development can be seen as part of agriculture, more specifically as specific type of agro forestry, namely an agrosylvicultural system.

Various options exist for plantations establishment for higher growth and survival rates. Total cultivation though expensive is the most appropriate .In the absence of more resources, NRC is the most viable method. A well-managed NRC has a similar effect to total cultivation ,costs are shared by the community and the forest department and both benefit

(Kagombe *et al., 2005*).without viable alternatives in sight the government should review the ban on NRC in areas where it has been working and establish mechanism to make it work in areas where it has failed .Further to that the FD must recognize the importance of community participation in forest management and in particular the role of the NRC management committees (Kagombe *et al.,* 2005). Taungya has been the second most important means of afforestation after the direct establishment in the tropics. It seeks to satisfy a social need (land for growing food and food production itself) and establishment of the plantations thus its difference in establishment is largely social but not silvicultural (Evans, 1992).

The Kenya forestry sector is today characterized by the problem that the rate of forest estate clear fell does not match the rate of replanting. This results in a rise to backlogs in plantation establishment. For example, of the 170,000 hectares of government owned forest plantations, 20,000 (12 %) hectares are open land or where recently felled and not replanted. Backlogs in forest plantation establishment refer to delayed operations in tree establishment and tending. By 1995 there were a total of 17657 hectares of planting backlogs, 1338 hectares of thinning backlogs, 22,750 hectares of pruning backlogs and 2175 hectares of coppice reduction backlogs (Wanyiri report, 1995). The Ol bolossat forest had over 1000 hectares of forest planting backlogs due to unsustainable tree harvesting and poor plantation establishment but the CFA through PELIS has reduced the backlog to less than 300 hectares (KFS, 2011). Most of the natural forest suffered degradation but now the communities are carrying out rehabilitation of degraded catchment areas.

The aim of KFS plantation programme is to have a sustainable production of forest products that will satisfy the present and future demand. This can only be ensured by timely replanting of harvested plantation areas. In recognition of the need to increase the forest cover in Kenya, the government through sessional paper no.1 of 2007 on forest policy provides guidelines for intensified tree planting inside and outside gazetted forests. Availability of high quality tree seed is key to realization of this policy. Seed quality is assured through KEFRI who is mandated to provide certified, site appropriate, high quality tree seeds in sufficient quantities to meet the national demand. KEFRI endeavors to best practices throughout seed production chain to ensure provision of high quality seeds (KEFRI, 2011). CFAs helped in tree operations and raised some 10.5 million tree seedlings during 2011/2012 compared to 5.8 million seedlings raised by KFS alone per year (KEFRI, 2011).

When the presidential ban came into force in 1999, the planting backlogs stood at 46,000 hectares but replanting efforts have since reduced it to 15000 ha. From 2002 to date

20,000 hectares of industrial forests plantation have been established through PELIS in gazetted forests all over Kenya. During the financial year 2011/2012 KFS had 16, 281 hectares of forests plantation under PELIS. The higher survival rate from 20% to 80% was due to better care for tree seedlings by PELIS farmers and improved forest governance by KFS. Improved tree cover has contributed towards achieving vision 2030's target of 10% forest cover which currently stand at 6.9% of the total land area.

KFS (2007) confirms that, the established young trees are from certified seeds, grows at high rate, fixing an average of 2.7 m3 carbon per hectare from one to age four. This leads to clean environment and reduction of global warming as stipulated in the Millennium Development Goals (MDGs, 2001). Shamba system (PELIS) is allowed under the Forest Act 2005 and is recognized as one way of raising plantations. One way to ensure that people benefit from forest is to allow system such as this, which benefit both the government and farmers.

Those plantation established under monoculture regime interfere with the forest biodiversity, and reducing its water catchment qualities. Farmers have been told to keep off indigenous forests. The noble peace prize laureate Prof. Wangari Maathai contends that "We cannot sacrifice indigenous forest at the expense of exotic plantations". Plantations represent a monoculture of trees, but a forest on ecology system. Maathai affirmed ‘' we are destroying local diversity and greatly the capacity of the forest to be effective water reservoirs (Paulo M, 2010). Forest scarcity induces higher prices of forest products, which encourage both better forest management and the establishment of woodlots and plantations. (Rudel *et al*., 2005) refer to this as the forest scarcity path, which forms the other main route towards forest transition. The success story of Machakos in Kenya provide an example (Tiffen *et al*., 1994)

On the Kenyan side, where piloting a livelihood plantations are being piloted under the PELIS, the system is dominated by maize rather than trees, with respect to quality, the tree will grossly under perform in terms of yield o timber of transmission poles, which people hope to sell at the end. Generally the PELIS approach as it is being implemented now will yield limited benefits in terms of improving forest cover and forestry products and services,

2. 5 Plantations Survival Rate and Forest Cover.

According to Kagombe *et al*., (2005) to attain an increased forest cover, the survival of the planted tree seedlings must be guaranteed. And this is possible through PELIS. As the farmers tend their crops by removing weeds and adding fertilizers the saplings too benefit as

they are not subjected to competition for nutrients with weeds and also they get nutrients from fertilization hence increased survival rate. Given that hygiene of the seedlings is secured through PELIS, higher survival rates for seedlings and lower susceptibility to pests and diseases.

The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004). It is paramount that to achieve a sustained forest cover from PELIS, then law enforcement efforts must be doubled. This will ensure that illegal activities that degrade the forest i.e. deforestation are controlled. The programme PELIS is improving tree cover in gazetted forest areas since it helps to improve survival rate and establishment of forest stands (M Nichlon, 2000). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012).

The reason for committing forest offences are often because of ignorance of the law and negligence They also include poverty, unemployment and the collections of medicinal plants for commercial purposes. Widespread bribery of forest guards and local police, lack of support to junior officers, shortage of vehicles and other equipment in the field to collect evidence of infractions and inadequate fines or sentencing continue to hinder enforcement efforts (World Bank, 2007 a) and create conflict between the authorities and communities in many natural forests.

Although the command and control approach of the past emphasizes law enforcement rather than crime prevention, low enforcement rather crime preventions, KFS understands that it must integrate compliance measures with greater efforts to involve communities in forest management which includes PELIS (Geller *et al.*, 2007). As the farmers tend their crops they also protect the young and the old trees from illegal poaching and destruction. The hygiene they keep in the PELIS areas also help in keeping off pests, diseases and also reduce incidences of fire outbreak. It is recognized that the current trend in forestry management is to move towards participation of communities in management of forest resources. It is difficult to police forests especially in areas where high population surrounds it. The communities are therefore involved in conservation and protection.

The way forward for shamba system is to consider it as a form of joint forest management where the communities will get shamba and in return participate in forest protection, adequate funding of forest protection, KFS enforcement and CFAs in terms of remuneration and housing facilities (KFW, 2013). At this rate of reward it is clear that maintenance of the plots in the second year and third year will be carried out by Taungya farmers. Given that they themselves hire labour for some activities; it is reasonable to assume that they might do the work if the reward matched the market rate. An alternative method of payment would be on a per seedling, survival basis, pro rata. (M K Mc Call and M M Skutsch, 1993).

On the whole the per seedling method is more likely to give satisfactory results, although there will be cases of hardship due to drought and difficulties especially if farmers have land of unequal quality. (M K Mc Call and M M Skutsch, 1993) Growth of the planted areas under shamba system has been reported to be higher than unattended tree plantations (Pudden, 1953, Konuche and Kimondi, 1990). This is contrary to the earlier view, which claimed that growing trees under Taungya reduce the growth (FAO, 1967b)

In Ngare forest station, Nyeri, the forester noted that CFA participation was saving the government a lot of money due to reduced cost of seedling production, tree planting and tree protection. He indicated that a plot of 100 hectares of planting backlog, 70,000 seedlings were needed and these would have cost KFS about 1.4 million. However, KFS was only compensating the community with Kshs 300,000, hence saving Kshs 1.1 million (Kagombe, 1998).

The farmers who have been part of community Forest Associations have been very helpful in managing and protection of the forest "when we plant trees in the forest the farmers have played a key role in the forest positively in line with the Forest Act 2005 which mandates that we work hand in hand with communities' said Mr. Chege. He added that KFS and the farmers have been collaborating and encouraging the PELIS scheme which enables farmers to plant crops in forest area for three years as they tend seedling, this arrangement has been very beneficial and has ensured 100 percent survival of the planted tree seedlings (KFS, 2014).

Mr. J. Mwanzia, the project manager (GZDSP) expressed satisfaction by the efforts of the community through protection of forest particularly against forest fires. "As we were starting out, there were perennial forest fires as is common with forest during dry seasons and during those times communities offered us little and sometimes no help at all, but since

engaging them directly we have experienced total change of attitude as the communities are first to spot fire and put it off even before involving the forester “said Mwanzia (KFS, 2014). When farmers dig out the mature potatoes, they are cautious not to hurt any of the seedlings. They are growing the produce in state land within, the forest gazetted zone (R. Manyaka, 2015). We play a great role in conserving the environment around the area. And that is why when we plant the tree seedling, we work so hard to ensure they survive” she noted. (R.Manyaka, 2015). Trees grown under the PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI, (R.Manyaka, 2015).

2.6 Cost of Plantations Establishment and Forest Cover.

One of the key objectives of PELIS was to reduce the cost of plantation establishment that currently stand at Kshs 54,500 per hectare at three years using the pitting and spot weeding method as compared to about Kshs 30,350 per hectare under 'shamba' system (KFS, 2007). KFS will benefit from this scheme by saving money that would otherwise be used for land preparation and subsequent maintenance of the planted areas which will be utilized in other conservation programmes. (Chamashama, *et al.* 1992) observed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial income to the peasant farmers and reduction of forest plantation establishment costs.

Enabor (1979) observed that, introduction of Taungya system into the humid tropics was a response to various socio-economic factors. For example in Nigeria, a major objective was to solve the problem of high cost of forest regeneration. One benefit of shamba system is low cost of plantation establishment. Taking wage of kshs 80.00 and current task rates, costs of establishment of plantation per hectare compounded at 15% to the end of 30 years rotation, was found to be approximately kshs 277, 000 for NRC areas. This means NRC is critical to economic development of plantations (World Bank Supervision Report, 1996). In 1990's FD reduced its staff through the retrenchment programme, which had an aim of reducing government expenditure. This means only a skeleton staff remains in the forests stations (Kagombe, 1998). Tree planting is faster as opposed to natural regeneration but a more costly way of restoring forest cover. Forest recovery is a slow process and when time is important forest plantations are economically and ecologically good alternative (Lugo, 1992). The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the

labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

The study by G C Monela,, *et al*., 1991 on analyzing the taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

The cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. The table below shows the cost of plantation establishment for each method by 2007. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. However, the system was abused such that prohibited farming tools were used like non-specified crops were planted and penalties for wrong doers were not honoured especially for those who rented out plots to outsiders who were not interested in conservation (FD, 2005). Effective cost/benefit sharing of forest resources e.g. through introduction of PELIS to reforest indigenous forest areas is a positive step. This could be adopted within the REDD+ framework (MFW, 2015).

Table 2.1: Task rates from FD (2005)

Activity	Total cultivation shs	Slashing shs	Slashing and spot hoeing shs	No preparation shs
Clearing	10,000	35,000	45,000	0
Staking out	1,500	1,500	1,500	1,500
Planting spos	1,500	3,000	3,000	3,000
Planting	1,500	1,500	1,500	1,500
Yr 1 tending	10,000	3,500	4,500	0
Yr 2 tending	10,000	3,500	4,500	0
Yr 3 tending	10,000	3,500	4,500	0
Total cost	**44,500**	**51,500**	**64,500**	**6,000**

Source: Task rates from FD (2005)

2.7 Livelihood Improvement and Forest Cover

Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and the survival of plantation trees, it has also provided other significant benefits such as making available arable land for the landless and contributing to food production. Plantation establishment and livelihood improvement scheme (PELIS) a modified form of non-residential cultivation that was practiced in earlier years in Kenya as a method of plantation establishment GOK, 2005; GOK, 2006;FAO, 2006). PELIS was initiated with the objectives of fully rehabilitating and protecting the forest and improving the livelihood of the forest adjacent communities (GOK, 2005). According to (Kafu, 2002) the expected benefits from PELIS were numerous. First, there would be increased forest cover, increased volume of water from the catchment areas, increased food production and there would be improvement in living standards of the communities living adjacent to forest due to increase in household incomes (GOK, 1994). PELIS is meant to improve economic gains of participating farmers while ensuring success of planted trees.

Deforestation and the resulting environmental degradation is a major problem in Kenya and a factor challenging food security, community livelihood and sustainable development. Forested catchment account for three quarters of planet accessible fresh water

resources which loses its quality as forests condition worsens (MEA, 2005). Fresh water catchment and soil preservation are important inputs to agriculture and food production. FAO should also arrange with the government of Kenya as host of the FAO regional conference for Africa (March, 2008), to include the key role of forestry in achieving food security on the agenda. (Geller *et al.*, 2007).

V.K. Agyemen,2003, also noted that food crops, especially annuals such as plantain, Cocoyam and Vegetables were interplanted with determined trees species. The food crops were normally cultivated for three years, after which the shade from the trees impeded further cultivation of the crops. Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops-(Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

Apart from successes observed through the MTS in the regeneration of degraded forest resources, the livelihood assets received by local people through the MTS intervention have led to significant increase in food productivity, income levels and general well-being of most households in all communities studied (Osei W and Eshun G, 2013). Interventions such as the MTS reveal that central governing agencies alone cannot have adequate capacity to combat deforestation and forest degradation or even monitor it. Local peoples' participation becomes a necessity for the implementation of the REDD+ intervention and related climate change mitigation measures to be effective (Osei W and Eshun G, 2013). Under the traditional taungya arrangements, Ghanian farmers had no rights to benefits accruing from the planted trees (Milton, 1994) and no decision making role in any aspect of forest management (Birikarang,2001).

A case study done in Njoro area East of Mau forest indicated that farming community in this area utilize the plantation area to grow food crops especially vegetables during the dry season. (B, Wangwe at el). Shamba system gives high return to farmers by close to Ksh 120,00 per hectare per year it creates employment to farmers and ensures food security.

(Kagombe, 2009). Forest management is important for people who gain a livelihood from the forest because people can only have a stable source of livelihood if forests are sustainably managed. In that way people can overcome their vulnerability based on forests (Hoogenbosch, 2010)

The project (GZDSP) has improved the livelihood of the communities living adjacent to forests through support of income generating activities (IGAs) which they depend on for survival. The model they engage in while rehabilitating degraded sites is Plantation Establishment and Livelihood Improvement Scheme (PELIS) which provided for communities to cultivate the forest area and plant crops for up to three years as they tend for the seedlings in the rehabilitated area. Mr. Kemau of the many beneficiaries said that the project activities enabled him buy a motorbike and purchase a ten acre piece of land in Gathiuru which he has started to construct. The communities utilize grazing rights, PELIS and fuel wood collection among other forest activities (KFS, 2014)

Kenya Forest Service Director, Mr David K. Mbugua on 10th may 2014 made a tour of Olbolossat forest, Nyandarua Zone to view the progress on areas of forest plantation under the CFA using PELIS that spell from 2009 to date. From the same unit of forest land a total of approximately 3,500 community forest Association members of which 2000 are able to generate profit from sale of crops while the remaining 1,500 benefits from grazing and other activities, have made Olbolossat success story. The next day the board visited Timboroa Forest station where they were received by members of the community led by CFA officials who took the board through the benefits they have enjoyed from their symbiotic relationship with the service in the form of PELIS.

In the nearby Nabkoi Forest station the board also saw the huge plantation backlogs that are typical of many areas where a shortage of resources caused backlogs (KFS, 2014). Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and survival of the plantation trees, it has also provided other benefits such as making available arable land for the landless and contributing to food production (Paul Okelo Odwori, Phillip M. Nyangweso and Mark O. Odhiambo, 2013). Under PELIS, CFA is allocated a piece of forest and where plantation trees are intended to be raised. The CFA shares it out among its members with each paying a small royalty. The farmers grow crops for food and for sale. In the second year (season) the farmers' plant preferred trees with the aid of KFS managers on the same piece of land.

In this way, farmers improve their food security, have some surplus for sale to get

income and their livelihood improve. (D. Walubengo and M Kinyanjui, 2010). It is a joy for farmers to benefit from PELIS as some people small pieces of land whose productivity is low can now generate enough profits to raise even wealthy families (R.Manyaka, 2015). Wanyoike said that since 2005, they have been farming on portioned acre producing high volume of potatoes and thus fetching good returns hence has significantly improved their living standards. “We have uplifted our living standards and we are so happy about it. Having a piece of land here (Aberdare Forest) to farm has created employment for us and we are making good profits” she said.

‘The MTS has been of immense benefit to the entire community, I could find majority of the youth in senior high school because their parents are now able to afford .Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small. Almost every member of this community involved in the MTS is able to grow more food stuffs for their household's consumption and for sale to earn some money to take care of their households. As for the trees we are willing to plant more and manage them well all we need from government is for us to have land and released to us on annual basis. Because we know that when trees are well taken care of ,they protect ourselves and the 40 percent benefit to MOTAG farmers who manage the trees well until maturity can support our children in the future EVEN when we are not alive" (Prince Osei *et al*., 2008).

Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars. “PELIS is offering communities an economic boom. Many CFAs are making millions from cultivating in the acres allocated to them” said Simiyu Wasike, deputy Director in charge of plantation and enterprise at Kenya Forest service. It a system promoting, plantation establishment, food security and better livelihood in the country and more than 185 CFAs exist in the country summing up the members exceeding 10,000 Wasike says (R. Manyaka 2015). Gerald Ngatia executive director for National Alliance for community Forest Association (NACFA), says successful PELIS is a major boosts to hundreds with of small scale farmer across the country. ‘Not only does PELIS create jobs for many but it greatly contributes to food security in the country. “Said Ngatia (R manyaka 2015).

2.8 Theoretical Framework

This study related two theories i.e. forest transition theory and environmental Kuznets curve theory.

2.8.1 Forest Transition Theory (FT)

The theory describes a sequence over time where a forested region goes through a period of deforestation before the forest cover eventually stabilizes and start to increase. This sequence can be seen as a systematic pattern of change in agricultural and forest land rents overtime. Increasing agricultural rent leads to high rate of deforestation. In describing how forest cover changes through the development phases of a country, this concept of forest transition is useful in depicting such changes. In that regard, the forest transition (FT) model describes the overall human induced changes of forest cover overtime and basically presents the combined effect of various drivers of on a national scale. The concept was proposed and articulated by Mather (1992) and later expanded by Rudel (2005) and (Kauppi *et al.*, 2006).

The model basically shows the transition in which a country with 40% forest cover goes through phases of decreasing forest cover through human activities till a period of maximum decrease before a country realizes that it can no longer afford to lose more forest cover and at which time, it begins to stop further net loss of forest cover and put in policies and measures to increase forest cover, in the case of Kenya the policy is PELIS. Graphically the trajectory is described at the national level by inverse J-shaped curve overtime. Furthermore the entire inverse J-shaped curve can be broken into four phases namely: pre-transition, early transition, late transition and post transition phase. These phases generally represent a time sequence of national development (Hnosuma *et al.*, 2012).

In Africa subsistence agriculture remains the dominant driver but the effect of commercial agriculture is likely to increase in early transition. Countries such as Angola, DRC, Zambia and Mozambique with respect to forest degradation, logging accounts for 52% fuel wood and charcoal 31%, fire 9% and livestock grazing 7%. The Kenya forest service can use its position on the curve for purposes of policy advocacy for the forest sector in general and for REDD+ in particular. Honosuma *et al.*, (2012) observed that the phases of transition are associated by drivers of varying significance as listed herein;

1. Agricultural expansion dominates the early and the late transition phases.
2. Fuel wood and fires- become more dominant in late and post transition phases.
3. Subsistence agricultural- fairly stable over all phases.

4. Urban expansion-largest in the post transition phase.

In general, nature the study notwithstanding, the study by Honosuma *et al*. 2012 places Kenya in the late transition phase in generalizing transition curve.

2.8.2 Environmental Kuznets Curve Theory

The second theory that also relates to forest cover is environmental Kuznets curve that contends that a U-shaped relationship exists between environment quality and economic development. The theory relates forest cover as key indicator of environmental quality and income levels.

2.8.2.1 Forest and the Natural Environment

Forests have been a source of life from time immemorial. A part from being the basis for a variety of wood and non-wood products and services forests are home to many forms of life and an essential role environmentally, including climate regulation, carbon recycling, bio diversity preservation and soil and water conservation. Biodiversity is widely recognized as a major source of sustainability, indicator may be identified to help detect human impact on nature including the health of ecosystem, the functionality of watersheds and so on.

2.8.2.2 Environmental Quality and Economic Well being.

On the basis of framework of Kuznets (1955) proposition asserts that economic growth may be harmful to the environment before reaching a certain stage but becomes conducive afterwards. Hence the relationship assumes a U-shaped. (Arrow *et al*. 1995).. The curve indicates that as the economy grows, environmental degradation increases up to certain level after which environmental quality improves. This means that at low income levels, environmental quality tends to decline along with economic growth, but ultimately improves as income levels rise beyond a threshold. The U-shaped relationship is dictated by the ability to spend on environmental amenities implying that wealthy countries have lower levels of environmental damage because they can afford to pay for environmental improvement, whereas poor countries cannot afford to emphasize amenities over material well-being.

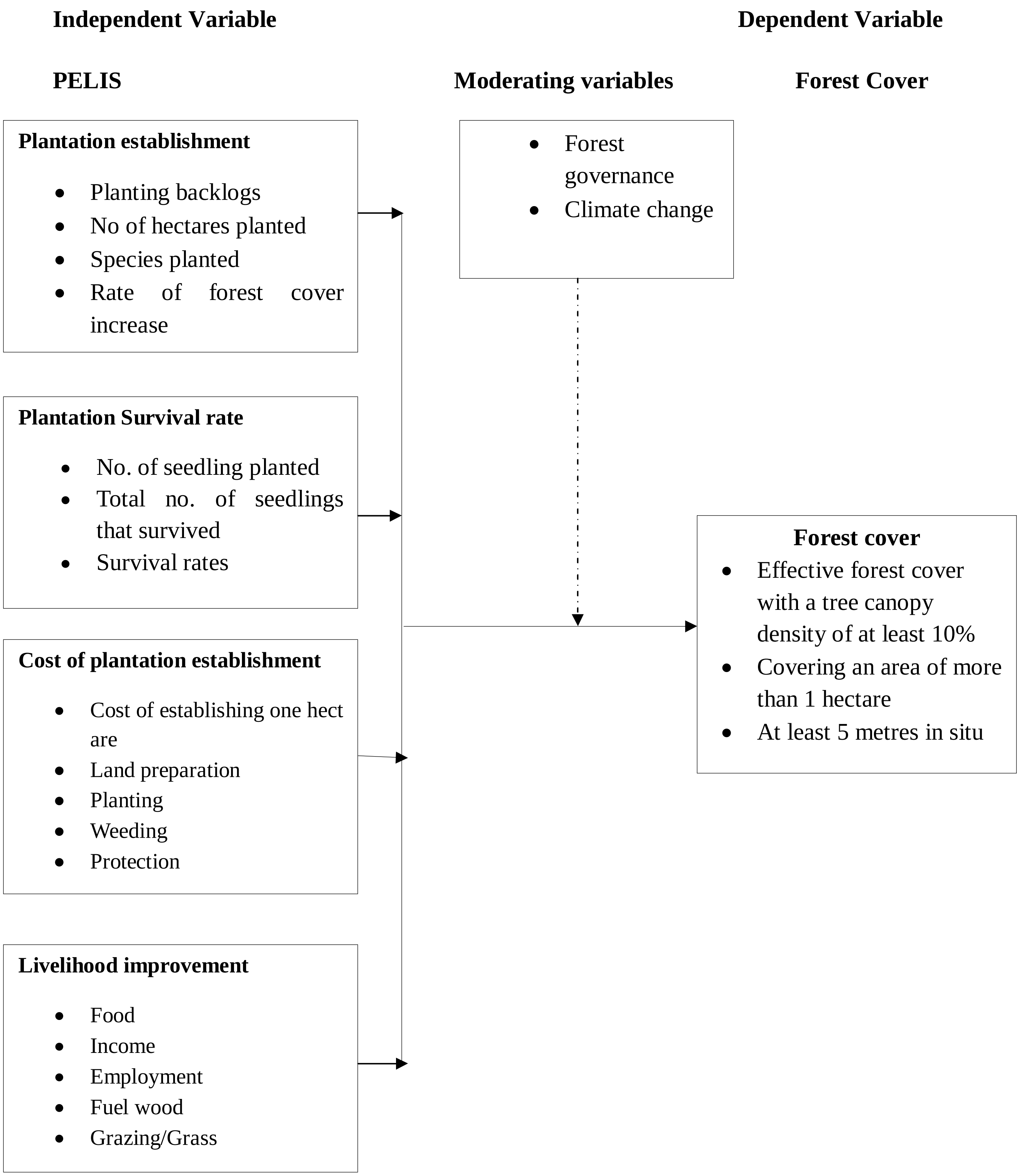
2.8.2.3 Is Forest Cover Related to Income Levels?

Human beings depend on forests for a variety of purposes. Population growth results in higher demand for forest based products and services. Therefore, it is reasonably to

postulate that population increase is a fundamental driving force of change in forest cover. (Mather *et al*. 1999) suggest that there is a theoretical basis for linking long term trends in forest use with economic developments including the emergence of forest transition as a society's income rises. Change in the state of the forest is subjected to a certain set of appropriate and constraints and income levels. From the perspective of developing countries, unless the gap between global diversity benefits and the needs of local people is narrowed the required economic growth will occur at the expense of much of the planets biodiversity (Fuentes-Quezada, 1996).

2.9 Conceptual Framework

Plantation Establishment and Livelihood Improvement Scheme (PELIS) was introduced in the Kenya's forestry sector to specifically alleviate planting backlogs, increase plantation survival rate, reduce cost of plantation establishment and improve the livelihood of the adjacent communities through food security. Its overall key objective was to increase the forest cover. The table below shows the two variables and their indicators.



(Source: Researcher, 2015)

Figure 1: Conceptual framework

Independent variable is PELIS while dependent variable is forest cover in this study. There are four factors that influence forest cover, and they include; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. The PELIS indicators would be the number of hectares planted, plantation survival rate, the cost of plantation establishment and the number of bags of maize and potatoes harvested. While on forest cover the indicator would be the area under forest cover in percentage. However, there are some other external factors that may behave like independent variable and has contributory effect on the relationship between independent and dependent variables. They include; forest governance and climate change factors. These factors could be termed as moderating variables.

On forest governance, if there are no proper rules, regulations, policies and code of ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, and prolonged dry spell. These will eventually lead to forest destruction and degradation hence forest cover loss.

2.10 Gaps in Literature Review.

The literature review on PELIS covered by this study has largely focused on its influence on food security to the forest adjacent communities and availing arable land to the landless. A wide knowledge gap of PELIS influence on forest cover is conspicuously missing and if available but only by mentioning. It is on this backdrop that this study will come handy for the policy makers in making informed policies and decisions besides ensuring sustainable production of the various forest products and services to the forestry sector players in the country.

MFW (2012) identified lack of clear policy on cost and benefit sharing that is not covered in the current Forest Act 2005. This is hindering afforestation and protection efforts by the key stakeholders as they feel they are short changed. Need for review of technical orders on spacing to increase the time farmers cultivate plots before canopy closure. Lack of stringent harvesting procedure is also escalating over logging, this include lack of felling and plantation establishment plans or look warm implementation in areas where they exists. (MFW, 2012).Lack of incentives to CFA members involved in PELIS make them less accountable to the programme rules and regulations. Conflicting sectoral policies e.g. Water

Act, Agricultural Act and EMCA, 1999 Act on wetlands protection. All these needs further research so as to ensure that all these bottlenecks are addressed.

Table 2.2: Knowledge Gaps

Thematic area	Author (s)	Method	Main findings	Knowledge Gaps
Influence of plantation establishment and livelihood improvement scheme on livelihood of Gaithiuru forest, Nyeri.	Mwatika N M (2013)	Descriptive research design that targeted CFA member	Study found that PELIS had a positive influence on livelihood of forest adjacent communities. The scheme diversified sources of livelihood, enhanced social and human capital.	The researcher did not study the influence of PELIS on forest cover. This study will explore how PELIS contribute to forest cover through enhanced area established with plantation.
Forest reclamation, REDD readiness and community livelihood sustainability. Assessing the viability of modified Taungya system as a decentralized Nature governance strategy.	Prince Osei Wusu Adjei and Gabriel Eshun (2008)	Survey method that targeted a total of 150 respondents in four forest fringe communities in a district in Ghana about their own forest and how it is governed.	Community participation in forestry decisions through the MTS enhances community resilience to combat climate change through improved community forest cover and livelihood.	The research targeted on modified taungya system as adecentralised nature governance strategy. This study will focus on the influence of PELIS on forest cover through plantation establishment, plantation survival rate and costs of plantation establishment.
Plantation establishment in Kenya – The shamba system case study	Joram K Kagombe and J M Gitonga (2005)	Survey method that targeted selected five districts	Total cultivation for plantation establishment is expensive but gives the highest survival and growth rate .	The study never focused on the influence of NRC on forest cover. This study intends to determine how much area has been established through use of PELIS

Challenges facing forest plantation establishment through shamba system; the case of Mucheene forest.	Ikiara, Isaac G (2010)	Survey method that targeted cultivators of six CBOs	There was adherance to the shamba system policy guidelines and community participation.	The study did not establish the influence of plantation establishment, plantation survival rates and cost of plantation establishment on forest cover.
Alleviating Food Insecurity and Landlessness Through PELIS in Kenya	Paul O. Odwori, Phillip M. Nyangweso and Mark O. Odhiambo (2013)	Purposive sampling was used to identify forest zones that practice PELIS in Kenya	PELIS contribute up to 2,049 hectares of arable land to the landless and up to 3 million bags of maize	The researcher did not focus on the influence of PELIS in increasing forest cover hence basis of this study.

2.11 Summary of Literature Reviewed

The study gathered literature from a wide range of authors whose studies were mostly based on the influence of PELIS on the livelihood of the forest adjacent communities but not on forest cover. PELIS has a number of components, some of the key components highlighted in this study include: plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement. During literature review the four components were found to influence forest cover. With regard to the influence of plantation establishment on forest cover the literature reviewed showed that indeed there is influence but was not discussed at length. On influence of survival rate on forest cover many authors established that well weeded, fertilized and protected plantations improved survival rates. Little literature was established with regard to the influence of cost of plantation establishment on forest cover, as farmers were providing labour for free from land preparation to protection and this was made possible because farmers were tending their crops too. Most researchers reviewed literature on the influence of PELIS on livelihood improvement of the forest adjacent communities but not livelihood improvement on forest cover. It is therefore important that the literature reviewed in this study will go a long way in bringing out the link between PELIS and forest cover.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter entails research design, target population, sampling design / procedure, sample size, data collection instrument, data collection procedure, measurement of variables, reliability test, and validation of instrument, data analysis, anticipated outcome and ethical considerations.

3.2 Research Design

This study explored survey research design. .It uses primary and secondary sources and qualitative data sources e.g. diaries, official records, reports etc. Survey is the systematic means of collecting information from people that generally uses a questionnaire (Grewal and Levy, 2009). Given that the study largely relied on the secondary data from the government offices and administering of interview schedules and questionnaires to the forest managers and the CFA members respectively hence it was necessary to use the research design.

3.3 Target Population

Target population was 6521 which included 6515 CFA members and 6 forest station managers. The study focused on plantations established 2001-2007, without PELIS and plantations established 2008-2014 with PELIS.

Table 3.1: Target population

Strata	No of CFA members	No of forest station managers	Total
Kapsaret	403	1	404
Cengalo	1650	1	1651
Nabkoi	1804	1	1805
Kipkurere	852	1	853
Timboroa	1406	1	1407
Lorenge	400	1	401
Sub –Total	**6515**	**6**	**6521**

3.4 Sampling Procedure and Sample Size

3.4.1 Sampling Procedure

Simple random sampling method was used in the two population groups because it is considered simple, most convenient and bias free. Every member of the population has equal and independent chances of being selected as respondents (Frankel *et al*, 2000). Sampling is a procedure of selecting a part of the population on which research is to be carried out, which ensures that conclusions from the study can be generalized to the entire population. Since the forest station managers were few, the researcher used non probability technique which is purposive sampling design to select the six forest station managers. (Leedy, 1993) observed that nothing comes out at the end of a long and involved study that is any better than the careful selection of the population using random sampling and stratified random sampling.

3.4.2 Sample Size

Given that the target population is less than 10,000 hence to calculate the final sample (Nassiuma 2000) sample size formula will be used. According to (Nassium, 2000) in most surveys , a coefficient of variation is the range of 21% ≤30% and standard error in the range 2% ≤ e ≤ 5% is usually acceptable. Therefore the study will use a coefficient variation of 30% and a standard error of 2%. Nassium (2000), gives the formula as follows; $n=Nc^2/c^2+(N-1)e^2$. Where; n= Sam ple size, N= population, c= covariance, e= standard error.

$$n = \frac{6515(0.3)^2}{0.3^2+(6515-1)\ 0.02^2} = 218.$$

Target population sample size is 218.

By using this formula a sample size of 6 and 218 for forest stations and CFA members will be used respectively. Below, is the table summary for target population in each study area and corresponding sample taken from each area. The study will use Neyman (2000) formula for stratum sample size allocation, Nh - (Nh/N) * n where sample size for stratum h, Nh= population size stratum h, N = total size of population, n= total sample size.

Table 3.2: Sample size for target population

Strata	**CFA Members**	**Sample Size**	**Forest Managers**	**Sample Size**	**Total Sample Size**
Kapseret	403	14	1	1	15
Nabkoi	1650	55	1	1	56
Cengalo	1804	60	1	1	61
Kipkurere	852	29	1	1	30
Timboroa	1406	47	1	1	48
Lorenge	400	13	1	1	14
Sub-Total	**6515**	**218**	**6**	**6**	**224**

Random sampling method was used to sample the CFA members for each forest statio n .This was done by assigning random numbers to them.

3.5 Data Collection Instruments

The study employed both primary and secondary sources of data, which included questionnaires, interview schedule and personal observations. In the case of secondary data, office records like statistical reports, scholarly journals, thesis, diary, and pamphlets, were used as well as Worldwide Web, text books, newsletters and magazines. Questionnaires as a primary source was used for data collection from the CFA members and interview schedules were used for forest station managers .A questionnaire is a form that features a set of

questions designed to gather information from respondents and whereby accomplish the researchers' objectives (Grewal and Levy,2009).

The questionnaires were structured. It is relatively economical method in cost and time, of soliciting data from a large number of people and the time for checking on facts and pondering on questions can also be taken by respondents, which tend to lead to more accurate information (William, 2005). Each item in the questionnaire is developed to address specific objectives, research questions or hypothesis of the study. The respondent is expected to react usually in writing. It assists in collection of information over a short period of time when time is a limiting factor.

The researcher personally together with competent assistants administered the questionnaires and the interview schedules so as to be assured of relatively uniform mode of questioning and questioning and subsequent respondents. The questionnaires were in two parts, Section A was about demographic information and Section B was about CFA food production activities through PELIS and plantations establishment 2001-2014. The study also employed face to face interview and personal observations from the six forest station managers to get clarity on some secondary data gathered from the office records. The reason for using interviews was that they are easy to administer since questionnaires are already prepared .The investigator follows a rigid procedure and sought answers to a set of pre-conceived questions through personal interviews (Kothari, 2004).

They also eliminate many sources of bias common to other instruments. This is because questions asked are usually confidential between the researcher and the respondent. Interviews clarify points that are not clear, collected from key informants by use of interview schedules. Interview schedule is important because it helps eliciting in depth responses that may enable deep understanding of the research problem. The interview schedules are comprised of A which is about demographic information while section B up to F about the four study objectives. Personal observations will also be employed in assessing the status of the plantations. This is where the researcher uses all the senses to perceive and understand the experiences of interest. It gives firsthand experience without respondents information as it occurs, explains topics that may be uncomfortable to respondents and notice unusual aspects. The researcher uses an observation checklist to record what he observes during data collection.

3.5.1 Pilot Testing of Instruments

A pilot study was carried out at one of the six forest stations and it's CFA. This was purposely to confirm the reliability and validity of the research instruments .The researcher also verified that ambiguous information was removed while deficiencies and weaknesses were be noted and corrected in the final instruments (Croswell & Miller; 2000). The main aim was to ensure clarity and suitability of the instruments that were used in the study. Reliability and validity is about usability of the instruments as it is about ease with which instruments can be administered, interpreted by participant and scored/interpreted by researcher. Usability considerations include how long it will take to administer, are directives clear, how easy is it to score etc.

3.5.2 Validity of Research Instrument

It is the extent to which an instrument measures what it is supposed and performs as it is designed to perform. This involves collection and analysis of data to asses accuracy of an instrument. It is prudent to use instruments from previous studies to ascertain content validity. It is one that has been developed and tested several times. It is about appropriateness of the content of an instrument. It should measure what one wants to know. To confirm this both the questionnaires and the interview schedules were tested by administering the same.

3.5.3 Reliability of Research Instrument

It refers to stability or consistency of measurement; that is whether or not the same results would be achieved if the test of measure will be applied repeatedly (Someh and Lewin, 2007) Reliability test of the instruments was done using cronbach alpha co-efficient. Nunally (1967) suggested that the minimal uptake reliability of 0.7 is recommended. To ascertain the reliability of the questionnaires, the researcher administered 10 questionnaires and two interview schedules for two CFA groups and two forest managers respectively. The modes of responses to the instruments were consistent and even time taken to answer the same.

3.6 Data Collection Procedures

The process of data collection commenced once the necessary certifications had been completed. The researcher sought permission from National Council for Science and Technology and finally got authority from the County Commissioner, Eldoret to carry out

research in the identified area. The researcher personally with the assistance of competent assistants administered the research instruments to the respondents after familiarization and informing the respondents of the purpose of study. Appointments were booked for various dates for data collection. The interview schedules for forest station managers were personally administered by the researcher. He also personally together with the assistants distributed the questionnaires and the completed instruments were verified and collected from the respondents.

3.7 Data Analysis

The data collected from both primary and secondary sources were checked for completeness, accuracy and relevance. SPSS was used to analyze the data. Descriptive statistics were used in analysis and presented in tables, frequencies and percentages. Also used were measures of central tendencies and dispersion where applicable.

3.8 Operationalisation of Variables in the Conceptual Framework

Table 3.3: Operationalization of Variables

Objective	Indicator	Measurement Scale	Tools of Analysis
To establish the influence of plantation establishment on forest cover in Uasin Gishu county.	-No of hectares established -No of species planted	Ratio Nominal Ordinal	Means, frequencies and percentages
To determine the influence of plantation survival rate on forest cover in Uasin Gishu county.	-No of seedlings established -Total number of seedlings that survived	Nominal Ordinal	Means, frequencies and percentages
To investigate the influence of cost of plantation establishment on forest cover in Uasin Gishu county.	-Cost of establishing one hectare	Ratio Ordinal Interval	Means, frequencies, percentages and standard deviation
To assess the influence of livelihood improvement on forest cover in Uasin Gishu county.	-No of bags of maize produced per acre -No of bags of potatoes produced per	Nominal Ratio Ordinal	Means, frequencies, percentages and standard deviation

	acre -No of bags of beans produced per acre -No of farmers who benefit from employment opportunities created -No of farmers who collect fuel wood from forest -Amount of money earned from sale of crops -No of farmers who cut grass/graze in the forest	

Source: Researcher (2015)

3.9 Ethical Considerations

To ensure compliance with ethical consideration the researcher sought permission from the relevant authorities. The respondents were given introductory letter for their permission to participate in the study. The names of the respondents were not disclosed unless on mutual agreement. All confidentialities of the respondents were not disclosed to the third party. The researcher observed honesty and practiced integrity (Shamhoo and Resnik, 2009). The data results, methods and procedures and probabilities were honestly reported by the researcher .Biasness was avoided in data collection, analysis and interpretations. The researcher avoided careless errors and negligence, being critical in examination of findings so as to keep good records of research activities.

CHAPTER FOUR

4.0 DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

Chapter four gives detailed data analysis, presentation and interpretations of the study findings. Data was collected and analyzed through the use of descriptive and inferential statistics. The data was then presented in tables. The discussion of the findings enabled the researcher to make inferences on the influence of PELIS in promoting forest cover. The study findings were then linked to the researcher's opinion in relation to the existing knowledge for close interpretation and discussion. The chapter is organized into sections beginning with presentation of the respondents' background information and the subsequent sections have been organized to follow the research objectives. There were a total of 224 people including 6 forest station managers and 218 CFA members involved in this study through the use of questionnaires and interview schedules.

4.2 Respondents Return Rate

4.2.1 Respondents Return Rate for Forest Managers

All the six forest station managers completed the interview schedules which represented 100% response rate. This response rate was enough to give the researcher confidence to carry on with the study. Table 4.1 shows the distribution of the response return rate amongst the six forest managers.

Table 4.1: Response rate for Forest Managers

Respondents	Sample	Response rate	Percent (%)
Kapsaret	1	1	100
Nabkoi	1	1	100
Cengalo	1	1	100
Kipkurere	1	1	100
Timboroa	1	1	100
Lorenge	1	1	100
Total	**6**	**6**	**100**

All the six interview schedules were returned filled. This very positive response could have been due to the use of purposive sampling technique that ensured all the six forest managers responded to the interview schedule as this was a small sample size. A wealth of experience and knowledge by the forest managers also contributed to the excellent response. The personal administering of the interview schedule by the researcher also significantly influenced the impressive return rate. Brief and precise interview schedules enabled the managers not to fill bored.

4.2.2 Respondents Return Rate for CFA Members

All the 218 CFA members sampled completed the questionnaires which represented 100% response rate. This was significant to allow the researcher to continue with the study. The table below shows the respondents return rate for CFA members..

Table 4. 2: Response Rate for CFA Members

Respondents	Sample	Response rate	Percent (%)
Kapsaret	14	14	100
Nabkoi	55	55	100
Cengalo	60	60	100
Kipkabus	29	29	100
Timboroa	47	47	100
Lorenge	13	13	100
Total	**218**	**218**	**100**

The researcher employed five competent assistants in each forest station who assisted in administering of the questionnaires to the CFA members. This enhanced coverage hence the positive response. The use of brief and precise questionnaires ensured the respondents were not fatigued. The questionnaires were also semi structured hence easier to comprehend and took little CFA members time. This response rate was considered reliable to make conclusions from.

4.3 Demographic Background of Respondents

4.3.1 Forest Managers

4.3.1.1 Level of Education

Given that education is a prerequisite for effective sustainable management of forest resources, the study established the education levels of the forest managers as 3(50%) had diploma as highest education level, 2(33.3%) had undergraduate education and 1(16.7%) had post graduate education. The mean number of years of working experience was 4.4. Table 4.3 indicates the education levels of the forest managers.

Table 4.3: Highest education level

Education level	Frequency	Percent
Diploma	3	50
Undergraduate	2	33.3
Postgraduate	1	16.7
Total	**6**	**100**

Education level and experience are critical tools in sustainable forest management as the manager is able to make sound decisions, interpret and implement policies and regulations that govern forestry practice). It also helps in efficient and effective management of resources both human and material. It is on this strength that the government is encouraging employees to scale up their level of education through gaining of more skills, knowledge and experience by offering study leaves and scholarships.

4.3.1.2 Age Distribution

The table below shows the age distribution of the forest managers. It was observed from the study findings that majority of them are in the age bracket of Over 50 years at 3(50%), 41-45 years 2(33.3%) and 46-50 years 1(16.7%).

Table 4.4: Age Distribution of Forest Managers

Category	Frequency	Percent (%)
18-25 years	0	0
26-30 years	0	0
31-35 years	0	0
36-40 years	0	0
41-45 years	2	33.3
46-50 years	1	16.7
Over 50 years	3	50
Total	**6**	**100**

Nzuve, (2010) observed that one of the key ingredients to an organizations strength and growth is having the right people in the right place at the right time. From the findings it was noted that majority of the forest managers were aging as there was none in the age bracket of 40 years and below. This poses a threat to succession and continuity of the organization. Positively age reflects the experience that one has gained over the years which is significant for increased effective and efficient productivity. There is likelihood of low productivity as the aging employees would tend to focus more on his forthcoming retirement as opposed to concentrating his efforts in working towards the achievement of the organization objectives.

4.4 Demographic Background of Community Forest Association Members.

4.4.1 Gender Distribution

Gender distribution is vital to forest management and conservation as each gender is well suited for specific activities. It was established from the study that 130(59.6%) CFA members were females while 88(40.4%) were males. Table 4.5 below depicts gender distribution for the CFA members.

.Table 4.5: Gender Distribution

Category	Frequency	Percent
Male	88	40.4
Female	130	59.6
Total	**218**	**100**

The study showed that the biggest population of the CFAs are females, who participate in PELIS, culturally the societies expects females to be in the forefront to ensure that food is available to the children and the family at large hence the increased percentage. It is them who spent most of the time with the children as opposed to the males.

4.4.2 Age Distribution

Most forestry activities are labour intensive especially PELIS. This would mean that energetic people take the forefront. It was established that majority of the CFA members were in the age bracket of 36-40 years with 112(51.4%), 41-45 years 30(13.8%), 46-50 years 25(11.5%), over 50 years 21(9.6%), 31-35 years 20(9.2%), 26-30 years 10(4.6%) while there was no representation in age category of 18-25 years. Their mean age (in years) was 38.4 with a range of (min 18, max 72). Table 4.6 shows the age distribution of the CFA members.

Table 4.6: Age Distribution of CFA Members

Category	Frequency	Percent
18- 25 years	0	0
26-30 years	10	4.6
31-35 years	20	9.2
36-40 years	112	51.4
41-45 years	30	13.8
46-50 years	25	11.5
Over 50 years	21	9.6
Total	**218**	**100**

It is evident from the study findings that majority of the farmers are at their prime age hence able to effectively use their energy in food production for their families. It is also important to note that at age 41 years the number of farmers starts to decrease, this could imply subsequent decline in energy and vigour. There is also low representation in ages between 18-35 years, as this could also imply that this youthful age; the youth are engaged in either schooling or other sources of income.

4.5 Plantation Establishment and Forest Cover

4.5.1 Planting backlogs

A huge planting backlog is an indicator of large unstocked plantation areas. There was a total backlog of 6066 hectares as at 2008 while as at 2014 there was 1,935.6 hectares. This represented 18.8% (2008) and 6 %(2014) respectively. The total forested area was 26,141.9 hectares as at 2008 and 30,272.3 hectares as at 2014 as indicated in table 4.7 below illustrates the planting backlogs.

Table 4.7: Planting Backlogs

Year	Total forest Area (Ha)	Forested are a (Ha)	Backlog (Ha)	Percent
As at 2008	32,207.9	26, 141.9	6066	18.8
As at 2014	32,207.9	30,272.3	1,935.6	6

The findings from the study established that planting backlog reduced from 18.8% to 6% as at 2008 and as at 2014 respectively. This represented a decrease of 60% in planting backlog. This development could be attributed to the influence of PELIS as a strategy in increasing forest cover. As the CFA members are allocated plots to cultivate their crops they also assist in planting and weeding tree seedlings alongside accepted agricultural crops.

4.5.2 Area Established through PELIS

The table below covers the area that was established 2008-2014 when PELIS as a strategy was introduced at the forest stations. The study shows that there was a steady increase in area of plantations established using PELIS strategy i.e. 2008(4.3%), 2009 (6.96%) ,2010(11.75%) ,2011(18.46%) 2012(12.78%),2013 (21.18%) and 2014 (24.56%).

Table 4.8: Area Established through PELIS

Year	Area Established (Ha)	Percentage (%)
2008	177.6	4.30
2009	287.4	6.96
2010	485.4	11.75
2011	762.6	18.46
2O12	528	12.78
2O13	874.8	21.18
2014	1014.6	24.56
Total	**4130.4**	**100**

It was noted from the analysis that a total of 4130.4 hectares was established with PELIS from 2008-2014. It is only 2012 (12.78%) which revealed reduced establishment area that could have been due to anticipated general election for 2013, prolonged drought and transfer of forest managers. The planting backlogs stood at 1935.6 hectares as at 2014 that could have been due to continued plantations felling that do not correspond to plantations establishment rate following the lifting of the logging ban in 2012 by the government and lack of approved felling plans as indicated in table 4.2 above. The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation. (O.A. Ndomba *et al.*; 2014). V. K. Agyeman at el., 2003, established that about 78 percent of Ghana current total area of commercial public and private forest plantations

of 35, 000 ha were established using the taungya system.

Hoefsloot *et al*., (2011) observed that although Shamba system existed in the years 2007 and below, it was abused by the implementers and never had stringent rules and regulations to govern it as PELIS does. However, as part of conservation efforts to replenish the forest cover, members of the CFA are supplied with certified seedlings, which they plant in the allocated portions and tend to them during cropping season (R.Manyaka, 2015). The area under PELIS increased from 2933 hectares in 2010/2011 financial year to 9939 hectares in 2012 /2013, according to the statistics by KEFRI (R Manyaka, 2015). The official said the scheme is a driving force in replenishing the forest cover while giving communities an opportunity to enjoy the forest economic benefits (R. Manyaka, 2015). Mr. Mwanzia the project manager (GZDSP) noted that the issue of ownership by community has improved rehabilitation efforts as there are fewer planting backlogs (KFS, 2014).

4.5.3 Major Species Planted

The table below shows the major tree species grown in the state forests. The study findings revealed that the species compositions were: *Cupressus lusitanica* 2,424.5 ha (58.7%), *Pinus patula* 1,086.3 ha (26.3%), *Eucalypts* 375.9 ha (9.1%) and indigenous 243.7 ha (5.9%).

Table: 4.9: Major Species planted

Species	Area established (Ha)	Percentage (%)
Cupressus lusitanica	2,424.5	58.7
Pinus patula	1,086.3	26.3
Eucalypts	375.9	9.1
Indigenous	243.7	5.9
Total	**4130.4**	**100**

The major species grown for industrial plantations and conservation in all the six forest stations included: *Cupressus lusitanica*, *Pinus patula* and *Eucalypts* species, all exotic. On conservation front, the common indigenous species included *Podocarpus falcatus*, *Podocarpus latifolius*, *Juniperus procera*, *Vitex keniensis*, *Olea* spp etc.The indigenous species are planted along catchment areas, degraded sites and for biodiversity conservation.

4.5.4 Rate of Increase in Forest Cover due to PELIS

The total forested area of the six forest stations was 32,207.9 hectares. Given that the total area established with plantations by 2014 was 4130.4 hectares, it therefore means that the percentage increase in forest cover during the PELIS period was 12.8%. Comparatively the percentage increase in forest cover without PELIS was 7.8%, this was from a total area of 2502.4 hectares of plantation established. Table 4.9 below illustrates the rate of increase in forest cover as a result of PELIS.

Table 4.10: Rate of increase of forest cover due to PELIS

Category	Total forest area (ha)	Area planted (ha)	Percent
As at 2008 (NO PELIS)	32,207.9	2,502.4	7.8
As at 2014 (PELIS)	32.207.9	4,130.4	12.8

According to the study findings on table 4.7 on the influence of plantation establishment on forest cover, there was an increase of 12.8% of forest cover following the planting of 4130.4 hectares of planting backlogs as at 2014. This therefore means indeed PELIS significantly contributed to forest cover as CFA members were allocated plots in clear felled areas and other open suitable areas to cultivate their crops; they too assisted in planting tree seedlings in the plots and tended them until canopy closure at about three years. By doing this KFS was able to realize plantation establishment of large areas as indicated by the study findings. As the farmers provided labour freely for land preparation, land cultivation, pitting, planting, weeding and protection. A well managed PELIS can significantly contribute to attainment of 10% forest cover by 2030 as envisaged in the vision 2030 and the constitution. Comparatively, the areas that were established without PELIS were low i.e 2502.4 (7.8%) hectares compared to 4130.4 (12.8%) hectares, area established with PELIS during the same period. This could have been low due to grassland planting that emphasized spot hoeing and spot weeding. There were also subsidy from multinational companies like Timsales, Pan Paper Mills and Raiply as they would provide funds for reforestation programmes of cleafelled areas. However, these have since stopped.

According to (FRA, 2015), the rate at which the world is losing its forests has been halved, but an area of 129 million hectares of South Africa has still been lost since 1990, UNs Food and Agriculture Organization report says. Improvement has been seen around the globe, even in the key tropical rainforests of South America and Africa. "FRA, 2015 shows a

very encouraging tendency towards a r education in the rates of deforestation and carbon emissions from forests and increases in capacity for sustainable forest management", said FAO director general Jose Graziano da Silva. Halting deforestation is a key focus of UN negotiations for a global pact limit disastrous climate change caused by greenhouse gas emissions.

The net annual rate of loss which takes into account the planting of new forests has slowed from 0.18 percent in the 1990s to 0.08 percent over the last five years. Planted forest area has increased by more than 110 million hectares since 1990 and now accounts for seven percent of the world's forest area (FRA, 2015). M Nicholson, 2000 observed that Kenya’s forest cover has tripled over the last 10 years increasing allaying fears of massive environmental degradation. According to government statistics released in March 2012, forest cover had risen from a low of 1.7 percent in 2002 to 5.9 per cent. The forest in both NP and FR which had been seriously degraded is now showing signs of recovery, pole stage trees are beginning to emerge from the climber tangles even where assisted regeneration had not been done earlier. (R Manyaka, 2015).

4.5.5 Plantation Establishment without PELIS

The study findings indicate that a total of 2502.4 hectares was established between 2001-2007 .It can be noted that is relatively low compared to the area that was established through PELIS 2008-2014 which was 4130.4 hectares. The largest area of plantation established was 474.6 hectares representing 18.97% in 2001 while the lowest was in 2002 with 199.8 hectares representing 7.98%. Table 4.10 below shows the plantations establishment without PELIS.

Table 4.11: Area Established without PELIS

Year	Hectares Established (Ha)	Percentages (%)
2001	474.6	18.97
2002	199.8	7.98
2003	372.6	14.89
2004	455.4	18.20
2005	328.8	13.14
2006	279.0	11.15
2007	392.4	15.68
Total	**2502.4**	**100**

The areas that were established without PELIS were low i.e 2502.4 (7.8%). Lack of funds from the government for reforestation programmes of clear felled areas was inadequate and this could have resulted to low plantation establishment coverage

4.6 Plantations Survival Rates and Forest Cover

4.6.1 Survival Rates of Plantations Established Through PELIS

The table below indicates the survival rates of plantation established through PELIS. From the study findings, the mean survival rate of plantations established with PELIS was highest in 2008(84.7%) and the lowest in 2013 (64.2%) as shown in table 4. 11. The study found that the survival rates of plantations established with PELIS were higher at 84.7% while without PELIS was 50.3%. The mean survival rate for plantations established with PELIS was 75.1%.

Table 4.12: Survival rates of plantations established through PELIS

Year	Area (Ha)	No. Of Seedlings Planted	No. Of Seedlings That Survived	Survival Rate (%)
2008	177.6	284,160	240,684	84.7
2009	287.4	459,840	338,442	73.6
2010	485.4	776,640	597,236	76.9
2011	762.6	1,220,160	920,000	75.4
2012	528	844,800	631,910	74.8
2013	874.8	1,399,680	898,595	64.2
2014	1014.6	1,623,360	1,245,117	76.7
Total	**4130.4**	**6,608,640**	**4,871,984**	**75.1**

The study findings could be attributed to the reduced competition for water and nutrients due to weeding, fertilization and low pruning done by the PELIS farmers. As the farmers weed their plots they too weed the young trees. As they apply fertilizers to their crops young trees too benefit from speel overs to the rooting system of trees. All these activities together with the protection the farmers provide to their crops, the young trees too are protected from straying livestock and wildlife hence increased survival rates.

Trees grown under PELIS have a 75 percent survival rate, which is good in reforestation programs as observed by KEFRI (Manyaka R, 2015). PELIS has positive effects on tree establishment cost and survival. Tree establishment has increased with less than 20% survival rate to 6000 hectares per year with a mean of 80% of survival rate. It is scientifically proven that forest industrial plantation established through PELIS has a much less to manage and is more likely to be preserved by forest adjacent communities (KFS, 2012). The seedlings survival rate under PELIS is generally good. Case studies done in Gathiuru, kombe and Thogoto forest stations registered over 75% survival rate compared to Bahati, Timboroa and Dundori that had survival rate below 75% (Kagombe, 2004).

4.6.2 Survival Rates of Plantations Established without PELIS

The table below shows the various plantation survival rates in different years. The highest mean survival rate recorded was 50.3 %(2007) and 50.3 %(2005) while the lowest was 29.6% (2002). On average the survival rate for all plantations established without PELIS was 45.2%, table 4.12 below.

Table 4.13: Survival rates of plantations established without PELIS

Year	Area (HA)	No of Seedlings Planted	No. of Seedlings Survived	Survival rate (%)
2001`	474.6	759,360	325,006	42.8
2002	199.8	319,680	94,625	29.6
2003	372.6	596,160	250,387	42
2004	455.4	728,640	336,632	46.2
2005	328.8	526,080	264,618	50.3
2006	279.0	446,400	223,200	50
2007	392.4	627,840	315,804	50.3
Total	**2502.4**	**4,003,840**	**1,810,272**	**45.2**

These low survival rates could be attributed to competition for water and nutrients faced by tree seedlings. As seedlings are established in grassland through spot hoeing and poor spot weeding is done instead of complete weeding as in the case of PELIS. These tree seedlings also did not benefit from fertilization and protection provided by farmers. Grazing

and browsing by livestock and wild animals on young plantations caused mass death of the saplings hence low survival rates. There was no protection offered by the government as in the case of PELIS where farmers offered protection for both their crops and saplings. (table 13).

4.7: Cost of Plantations Establishment and Forest Cover

The study sought to find out if PELIS contributed to reduction in the cost of plantation establishment. From the study it came out that cost of plantation establishment for both with and without PELIS was 39,527/= and 50564/= per hectare respectively across all the six forest stations under study. This shows what KFS is saving Kshs 11,037 (21.8%) in establishing one hectare of plantation by use of PELIS. Table 4.13 below illustrates the above.

Table 4.14: Costs of plantation establishment

Category	Cost/ha without PELIS (Khs)	Cost/ha by PELIS (Khs)	Difference	Percent
Costs	50,564.00	39,527.00	11,037.00	21.8

The findings of the study established that the government could save up to Kshs 11,037 (21.8%) per hectare by use of PELIS. This money could be channeled to other activities like pruning. Given that farmers carry out array of activities at the preliminary stages of plantation establishment, the cost of establishing one hectare of plantation is reduced. The activities include land preparation, cultivation, pitting and planting. As PELIS farmers provide labour by carrying out the activities for free as they prepare land for their crops, the government saves a lot of money that would otherwise have been used to pay casuals.

According to FD, 2005, the cost of plantation establishment per hectare for the first 3 years was as low as sh.6000.00 for no preparation and as high as Ksh.44, 500.00 for total cultivation. The plantation was considered established after the third year when the tree canopy closed in. Under the shamba system most of the costs are borne by the farmer who benefited from the planted food crops. It was also established that multinational companies like Rai Ply, Tim Sales and Comply who are major consumers of forest raw materials insignificantly participate in reforestation of areas they have clear felled hence contribute to

continuous increase in planting backlogs. These companies should substantially compliment government efforts in reforestation in terms of raising seedlings and provision of funds for labour engagement during plantations establishment. The (FSD) assist with the technical advice, survey and demarcates degraded forest reserve areas and supplies tree seedlings and stakes to mark planting spots, while farmers provide all the labour inputs in form of site clearing, staking to guarantee uniform tree spacing , planting, tree maintenance and fire protection (Interview Zonal plantation manager of FC , April 2010).

4.8 Livelihood Improvement and Forest Cover

4.8.1 Main source of Livelihood

The illustration in table 4.14 is on the main sources of livelihood for the CFA farmers. They largely participate in PELIS to enhance their livelihood through diversification of sources of livelihood in form of more adequate income, increased wellbeing, and improved food security among others. It was established from the study that majority of the CFA members 210(96.3%) reported their main source of livelihood was farming -PELIS. Only 2.7% and 0.9% indicated business and employment respectively as sources of livelihood.

Table 4.15: Main source of livelihood

Category	Frequency	Percent
Farming-PELIS	210	96.4
Employment	2	0.9
Business	6	2.7
Total	**218**	**100**

The study showed that PELIS significantly contributed to food security for the forest adjacent communities as shown on table 4.14. The study findings established that 210 (96.3%) of the CFA members source of livelihood was farming-PELIS. Food security has been a challenge to our society especially the vulnerable segment. It is therefore notable that PELIS provided excellent opportunity to the poor as they are able to improve their livelihood by cultivating their crops in the forest alongside trees. By doing so they are able to secure

food for subsistence consumption and are able to sale the surplus for income so as to get other necessities of life like, clothes, shelter, food, education etc. The farmers too are able to graze their animals in the forest hence improved animal production for meat and milk and even sale for income. They are also able to get firewood and secure employment opportunities hence improved livelihood. Fresh water catchment and soil preservation are important inputs to agriculture and food production

Shamba system modified as (PELIS) was a preferred method of establishing forest plantations because of reduced costs and increased food productions in addition to generating income for farmers from the sale of surplus crops- (Kshs. 124,000 per hectare per year in Kiambu District, for example (Kagombe, J.K, and J. Gitonga, 2005). Under MTS, local people receive some livelihood assets as means of ensuring the sustainability of their livelihoods and for reducing household poverty. Land was the basic natural asset that local people received through the MTS intervention for both food crop cultivation and the establishment of tree plantations to regenerate the degraded forests. In this regard, MTS addresses the difficulty of local people to obtain fertile land for food crop cultivation (Osei W and Eshun G, 2013).

4.8.2 Shamba Ownership in the Forest

As illustrated in table 4.15 below, it was observed from the study that majority of the CFA members 214(98.2%) owned a shamba in the forest as shown in table 4.15 below. The average size of shamba owned by each former was one acre.

Among them 4(1.8%) that do not own a shamba, the reasons given were that two had not yet been allocated, one has no time to manage the farm while the other has his own farm.

Table 4.16: Shamba Ownership in the Forest

Category	Frequency	Percent
Owns forest land	214	98.2
Do not own forest land	4	1.8

The findings indicate that majority 214 (98.2%) of the farmers own plots in the forest. This could show that the main source of livelihood of the farmers was farming and also the shambas back at home were inadequate for both subsistence and commercial food production. For the farmer who does not own a plot in the forest, this could imply that the

farmer does only grazing or cut and carry grass in the forest but does land cultivation at home. The one that has not been given one is probably still new in the CFA membership and shambas are exhausted hence has to wait until the shambas are available i.e. until clear fell is done. For the 214 members that owned a shamba, the median (IQR) number of acres was 1 (0.5, 2). Food shortage which used to be a burden several years ago is now a thing of the past because with the MTS every hard working member of the community has access to land for trees and food crops cultivation no matter how small (Prince Osei *et al*.2008).

Although PELIS was established to promote forest plantation development through enhanced forest establishment and survival of plantation trees, it has also provided other significant benefits such as making available arable land for landless and contributing to food security (Paul O Odwori at el., 2013).

4.8.3 Crop Harvest per Acre

The table below shows crop production per acre by the CFA members. On average, the PELIS farmers harvest 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre as shown in table 4.16.

Table 4.17: Crop harvest per acre

Category	Bags/acre	Max	Min
Maize	22	40	1
Potatoes	54	150	1
Beans	5	60	0.5

This means the farmers were able to get food from crop diversification and can dispose of the surplus to meet other family needs. It is on the basis of these crops that the farmers derive their livelihood from and the main driving force behind going for the government land.

4.8.4 Crops Grown Alongside Trees

From the study findings, the table below shows the response of CFA farmers if they grow their agricultural crops alongside trees. Majority of the members 202(92.5%) grew either crops alongside tree seedlings while only 16(7.5%) did not.

Table.4.18: Response of farmers on crops grown alongside tree

Response	Frequency	Percent
Yes	202	92.5
No	16	7.5

This means that PELIS ensured plantation establishment .However for the 16(7.5%) it could imply that their plots were in their first year of cultivation hence not ready for tree seedlings planting (table 4.17). The farmers are allowed to cultivate food crops which are planted between the trees on the same lands (Evans, 1992).

4.8.5 Types of Crops Grown.

As indicated in table 4.18 below, there are three main crops grown by CFA farmers in the scheme. Hundred and sixty nine (77.6%) grew maize, 109(50%) potatoes while 95(43.5%) grew beans. The potatoes are grown around the highland plateau of the county.

Table 4.19: Type of crops grown

Crop	Frequency	Percent
Maize	169	77.6
Potatoes	109	50.0
Beans	95	43.5

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The study showed that the stable food was maize which has the highest percentage; the second was potatoes and lastly beans. All these were grown for subsistence use and any surplus was sold for income to enable the families acquire other necessities. Among the crops grown under the PELIS include potatoes, maize and beans whose total monetary value is estimated at 146 million U.S dollars (R Manyaka, 2015).

4.9 Other Benefits from PELIS

A part from securing food from PELIS, the farmers also immensely gets other benefits that ultimately enhance their livelihood socially, economically and culturally. These included; fuel wood 214 (98.2), grazing 196 (89.9%), source of income 183 (83.9%) and 155 (71.1%) as shown on table 4.19.

Table 4.20: Other Benefits from PELIS

Benefit	**Frequency**	**Percent**
Employment	155	71.1
Firewood	214	98.2
Grazing	196	89.9
Source of income	183	83.9

The study observed that besides PELIS providing food security as the main benefit there were other benefits that came along with it to the PELIS farmers. These included; source of fuel wood for majority of the CFA members 214(98.2%). The second most important other benefit it provided was grounds for livestock grazing 196(89.9%) many members of the adjacent communities were also able to get income 183(83.9%) from the sale of the PELIS crops besides provision of employment opportunities too 155(71.1%). All these other benefits were geared towards enhancing the forest adjacent communities' livelihood (table 4.19).

4.10 Perception of PELIS as Plantation Establishment Strategy by Forest Managers.

The table below shows the perception of PELIS by forest managers. All the six forest station managers applauded PELIS as the most appropriate method of plantation establishment 6 (100%). This was due to reasons outlined on table 4.20.

Table 4.21: Take on PELIS by Forest Managers

Comparison	Frequency	Percent
It enhances water absorption and retention for plant use	6	100
It reduces weeds, therefore less competition for nutrients hence increased plantation survival rate	6	100
It keeps away animals which may browse seedlings unlike grassland which is prone to animals and percolation of water is less	6	100
It reduces establishment costs and damage by pests and rodents	6	100
It significantly contributes to backlog reduction hence increased forest cover	6	100
It contributes to food security for the forest adjacent communities	6	100

Two most common methods of plantation establishment are grassland and PELIS. The former, involved establishment of plantations on grassland, without total cultivation but hoeing of planting spots, while the latter involves total cultivation of the area plantation is to be established. From the study all the forest station managers 6(100%) observed that the strategy was positive in that it enhanced plantation hygiene hence less competition for water and nutrients by trees. PELIS strategy also ensured that animals which may browse on young seedlings are kept away. It also helped to reduce the plantation establishment costs as the cost of land preparation and planting are borne by the farmers. Damages caused by pests and diseases were reduced, plantation hygiene ensured trees were not attacked by the pests and diseases. As farmers tended their crops and did fertilization, thus trees also benefited from fertilizers hence faster growth (table 4.20).

4.11 Challenges Encountered by Forest Managers during the PELIS Implementation.

Table 4.21 below depicts the challenges encountered by forest station managers during the implementation of PELIS. The study established the following as the most common challenges; interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba

6(100%). There was also late shamba preparation by farmers 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers 4(66.7%), uprooting of saplings 3(50%), need for close supervision 6(100%) during planting and after and lack of transportation means 3(50%).

Table 4.22: Challenges encountered by forest managers during the PELIS period

Challenges	Frequency	Percentage
Interference of seedlings rooting system during cultivation	5	83.3
Periodical straying of livestock/wild animals in the shambas	6	100
Late shamba preparation hence delayed time of planting	4	66.7
Over pruning of trees by those doing PELIS	4	66.7
Use of agrochemicals	6	100
Transportation of seedlings during planting	3	50
Uprooting of the saplings purportedly to create space for further cultivation	3	50
Supervision of farmers to avoid damage to the planted seedlings	6	100

The study found out that the most common challenges faced by the forest managers during the scheme implementation was interference of tree seedlings during cultivation and harvesting 5(83.3%). Another challenge was periodical straying of livestock /wild animals in the shamba hence browsing or trampling on young tree seedlings 6(100%). There was also late shamba preparation by farmers which affected planting time 4(66.7%). Use of agrochemicals 6(100), over pruning by PELIS farmers also affect the growth of the trees, uprooting and deliberate disturbance of the rooting system of the young seedling by the PELIS farmers 4(66.7%).This was to enable the farmers to continue cultivating their shambas for a long period. This affected the growth of young trees hence reduced the survival rate.

It was also established that PELIS require close supervision 6(100%) during planting and after to avoid damage to the planted tree seedlings by the PELIS farmers. Lack of transportation means 3(50%), for the seedlings during planting was also observed by the forest station managers as a hindrance to effective planting exercise. Abandonment of one

year established plantations by the PELIS farmers created room for trees competition with weeds for water and nutrients and grazing and browsing by both domestic and wild animals (table 4.13).

V. K . Agyemen, 2003, observed that in traditional taungya system there were many challenges that included, increased incidences of sabotage to tree seedlings by farmers, the farmers had more interest in their agricultural crops than the forest trees and there were many incidences of forest land encroachment. Farmers deliberately killed planted seedlings to extend their tenure over portion of land , since a successful plantation meant the discontinuation of cultivation on allocated plots, girdling of stems, cutting trees above and below ground, debarking and over pruning. Other challenges were; Cleared more land for plantation development than needed for the available seedlings. Failed to weed around tree seedlings , whereby retarding their growth so as to extend land use rights beyond three years. Illegally farmed other areas in forest reserve, degraded or not , which were not allocated for taungya.

Planted food crops that were not compatible with the tree crops leading to reduced tree growth, lack of supervision by forestry officers. Inadequate financing mechanisms, abuse of powers by public officials especially in farm allocation (Agyeman *et al.*, 2003), over pruning of trees, inappropriate use of agrochemicals and encroachments of forest land for farming.

4.12: Challenges Encountered by Farmers during PELIS Implementation

Table 4.22 below brings out the challenges encountered by farmers during PELIS implementation. The findings of the study were; destruction of crops by wild animals 212(97.2%), livestock destruction 201(92.2%), pests and diseases 189(86.7%) and climate change 153(70.2%).

Table 4.23: Challenges Encountered by Farmers during PELIS period

Challenge	Frequency	Percent
Livestock destruction	201	92.2
Destruction of crops by wild animals like monkeys	212	97.2
Pests and diseases	189	86.7
Climate change	153	70.2

The PELIS farmers cited destruction of crops by straying livestock 201(92.2%), wild animals 212(97.2%) graze and browse on crops, infection and attack by pests and diseases on crops 189(86.7%)i.e. maize lethal necrosis disease and maize stalk borer were mentioned as a threat to crops production by farmers. Effects of climate change 153(70.2%) as it happened in 2014 posed a challenge to the farmers as the rainfall was inadequate and erratic. All these could result to great loses by farmers in both crops and livestock production.

Following wanton destruction of Mau forest there is significant change in rainfall patterns and temperatures .Rainfall seasons sets in late for a shorter period compared to previously with prolonged dry spells, temperatures are relatively high hence high rate of everpotranspiration and dehydration on vegetations and animals besides drying up of water bodies. This makes PELIS activities very challenging especially tree establishment (table 4.14). Farmers also indicated that they are being exploited by KFS as they don't get a share from the sale of the various forest products given that the Forest Act 2005 recognizes the CFA as key stakeholders in forest management.

4.13 Other factors influencing forest cover

On forest governance, if there are no proper rules, regulations, policies and code of conducts and ethics like Forest Act, forest policy, strategic plan, professionalism and integrity then little can be achieved towards forest cover increase. Climate change may compromise efforts in forest cover increase, in terms of reduced annual rainfall, unpredictable weather patterns, floods and prolonged dry spell. High poverty levels will drive the community to go into the forest to draw their livelihood. This will eventually lead to forest destruction and degradation hence forest cover loss and consequently loss of forest related benefits that would otherwise been assured if there was sustainable utilization of forest related resources.

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five reviews the whole study findings summary, conclusions and recommendations based on the study objectives. The study title was the influence of PELIS on forest cover- a case of Uasin Gishu County, Kenya. The study objectives were: to establish the influence of plantation establishment on forest cover, to evaluate the influence of plantations survival rate on forest cover, to determine the influence of cost of plantations establishment on forest cover and finally to assess the influence of livelihood improvement on forest cover.

5.2 Summary of the Study Findings

The study findings were summarized as below:

5.3. Influence of Plantation Establishment on Forest Cover

On the influence of plantation establishment on forest cover, a total of 4130.4 hectares was established with PELIS from 2008-2014. This represented 12.8% forest cover increase of the total planting backlog of 4438 hectares as at 2008 while that without PELIS was 8.4% increase. The study findings showed there was steady increase in plantation established using PELIS while that one without was relatively low. As the farmers were given plots to grow their crops, they too were expected to provide labour for land preparation, pitting, planting and protection of the planted trees.

5.4 Influence of Plantations Survival Rates on Forest Cover

In respect to plantations survival rate on forest cover, the average survival rate of plantations established with PELIS according to the study was (75.1%). The mean survival rate of plantations established without PELIS was 45.2%. The findings showed that as the farmers tended to their crops in form of weeding, fertilization and protection, trees too benefited from the same. Competition for water and nutrients was minimized through complete weeding.

5.5 Influence of Cost of Plantations Establishment on forest Cover

On the influence of plantation establishment costs on forest cover, the study established that plantation establishment with PELIS costs Kshs 39,527 and without PELIS Kshs 50,564. This translates to Kshs 11037 (27.9%) saving for the government. Land preparation, cultivation, planting, weeding and protection are very expensive exercises. And

all these are subsidized by PELIS farmers. Hence the savings can be redirected to other essential activities like plantations pruning.

5.6 Influence of Livelihood Improvement on Forest Cover

With regard to influence of livelihood improvement on forest cover, the study findings showed that the majority of the CFA members 210(96.3%) indicated that their main source of livelihood was farming-PELIS, only 6(2.7%) and 2(0.9%) indicated business and employment respectively. On average the farmers harvested 22 bags, 54 bags and 5 bags of maize, potatoes and beans per acre respectively. The findings also indicated that 169(77.6%) of the PELIS farmers grew maize, 109 (50%) potatoes while 95 (43.5%) grew beans. Many families were able to earn a living from PELIS especially food, fuel wood, employment and grazing

5.7 Conclusions of the Study

Total cultivation for plantation establishment is expensive but gives the largest established plantations area, the highest survival and growth rates. In the absence or inadequate funding or new technologies PELIS remain a viable option for plantations establishment. PELIS benefits both KFS and farmers, though mechanisms to ensure more benefits to farmers should be explored. PELIS plays a very vital role in forestry management as it is a component of participatory forest management which brings on board other key stakeholders like the forest adjacent community in sustainable management of forest resources. There was a significant increase of 12.8% forest cover of the plantations established through PELIS which was 4130.4 hectares from 4438 hectares as at 2008, hence increased forest cover. A well managed PELIS that observes the laid down guidelines can go a long way in contributing towards attainment of a 10% forest cover as a country by the year 2030 as envisaged in vision 2030 and the constitution.

The study established that the mean survival rates for plantations established with PELIS were higher compared to plantations established without PELIS i.e. at 75.1% and 45.2% respectively. This could have been due to reduced competition for water and nutrients as the PELIS farmers weeds both the young trees and their crops besides fertilization that trees benefit too from. As the farmers protect their crops from straying livestock and wild animals trees too benefits.

The cost of plantation establishment with PELIS (Khs 39,527) was reduced by

Kshs.11037 as compared to plantation established without PELIS (Khs 50,564).This reduction translates to 27.9% savings for the government. This could have been possible due to array of activities farmers carry out for free like clearing, cultivation, pitting, planting, weeding and finally protection. However, the government subsidizes the labour costs.

The study also revealed that 210(96.3%) reported that farming -PELIS is their main source of livelihood. On average the PELIS farmers harvested 22 bags of maize, 54 bags of potatoes and 5 bags of beans per acre, With 169 (77.6%) growing maize, 109(50.0%) potatoes while 95 (43.5%) grew beans. It can also be deduced that PELIS targeted the poor in the society and the majority grew maize as it is a stable food crop in Kenya.

5.8 Recommendations

The researcher recommends that:

1. Forest adjacent communities should be given incentives or other sources of income like establishment of nature based enterprises e.g apiculture, ecotourism, acquaforestry e.t.c in forest reserves so that they can devote portion of their land for tree planting hence attainment of 10 percent forest cover as internationally recommended.
2. There should be very close supervision of all PELIS activities carried out by the farmers to ensure minimal damage to the established plantations. PELIS guidelines should be adhered to and implemented to the latter (Appendix vii). The Forest Act no. 7 of 2005 provisions on governance should too be enforced. This would enhance plantations survival rates.
3. Multinational companies like Rai Ply, Tim Sales, and Comply among others should be made to supplement government efforts in terms of contributing some funds for hiring labour for plantation establishment programme as they are the major consumers of forest raw materials. This can go a long way in lowering the cost of plantations establishment.

4. There is need for the government (KFS) to fast track the Forest Management and Conservation Bill of 2014 that has a clause on cost-benefit sharing between KFS and the CFAs as the latter feel they are short changed on forest products benefits especially the share from the sale of timber that eventually would enhance their livelihood.

5.9 Suggestions for further Research

The researcher suggests the following areas for further studies:

1. The influence of PELIS on the plantation rotation age.
2. Cost benefits sharing among key stakeholders.
3. Study on increasing spacing in plantation establishment.

5.10 Contribution to the Body of Knowledge

It was observed from the literature reviewed that there was insignificant relation to the influence of PELIS notably; plantation establishment, plantation survival rate, cost of plantation establishment and livelihood improvement to forest cover in Kenya and globally. The literature reviewed failed to show empirical evidence on how PELIS influences forest cover. It is therefore vital to note that this study has brought out the contribution of the scheme towards attainment of the recommended international thresh hold of 10% forest cover of a country's total land area.

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APPENDICES

APPENDIX 1: TRANSMITAL LETTER FOR CFA MEMBERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu County. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly fill in the questionnaire and thank you in advance.

Yours faithfully,

Tobias Achungo.
L50/71180/2014

APPENDIX II: QUESTIONNAIRE FOR CFA MEMBERS

SECTION A: Demographic information (tick where applicable)

1. What is your gender? (a) Male (b) Female
2. How old are you? (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45 (e) 46-50 (f) Over 50 years

SECTION B: Livelihood Improvement and Forest Cover

1. What is the main source of your livelihood?

   (a) Farming- PELIS (b) Employment (c) Business

2. Do you own a shamba in the government forest?

   (a) Yes (b) No

   If no, why?...

3. If yes, How many acres?..

4. What do you grow? (a) Maize (b) Potatoes (c) Beans

5. How much yield do you harvest per acre?

   (a) Maize……….. (b) Potatoes……….. (c) Beans…...

6. Do you grow your crops alongside tree seedlings? (a) Yes (b) No

7. What other benefits do you get from PELIS?..

8. What major challenges do you encounter during PELIS period?

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APPENDIX III: TRANSMITAL LETTER FOR FOREST MANAGERS

Dear respondent,

I am a student at University of Nairobi, pursuing a degree course in Master of Arts in Project Planning and Management. As part of my course work, I am carrying out a research on influence of PELIS on forest cover in Uasin Gishu county. The information collected is purely for academic purpose and shall be treated with utmost confidentiality, kindly respond to the interview schedule and thank you in advance.

Yours faithfully,

Tobias Achungo.

L50/71180/2014

APPENDIX IV: INTERVIEW SCHEDULE FOR FOREST STATION MANAGERS

SECTION A Demographic Information (tick where applicable)

1. How old are you?

   (a) 18-25 (b) 26-30 (c) 31-35 (d) 36-40 (e) 41-45

   (e) 46-50 (f) Over 50 years

2. What is your highest education level?

   (a) Diploma (b) Undergraduate (c) Postgraduate

3. What is your work experience at this station?......................................

SECTION B: Livelihood Improvement and forest cover

1. Do you have a CFA? (a) Yes (b) No
2. How do they participate in PELIS?...

SECTION C: Plantation establishment and forest cover

1What is the total forest area of your station? ……………………………………….

3. What was your planting backlog as at 2008?..
4. What was your planting backlog as at 2014?..
5. How many hectares were established each year with PELIS between 2008-2014 ?.........
6. How many hectares were established each year without PELIS between 2001-2007?.....

SECTION D: Plantations survival rate and forest cover

1.What were the survival rates of the plantations established with PELIS between 2008 and 2014?

(i) 2008……. (ii) 2009……. (iii) 2010…… (iv)2011…..

(v) 2012….. (vi) 2013………….. (vii) 2014…………..

2. What were the survival rates of plantations established without PELIS between 2002-2007?

   (i) 2002…… (ii) 2003… (iii)2004…… (iv)2005…

   (v) 2006…… (vi) 2007……..

SECTION E: Cost of plantation establishment and forest cover

1 What is the cost of establishing one hectare with PELIS?..

2 What is the cost of establishing one hectare without PELIS?.......................................

SECTION F: PELIS Perception and Challenges

1. What is your take on PELIS and Grassland as main methods of increasing forest cover?……………………………………………………………………………………
………………………………………………………………………………………………
2. What are the major challenges you face while implementing PELIS……………………

APPENDIX V: WORK PLAN

ACTIVITY	DURATION
Topic selection	March, 2015
Proposal development	March, 2015
1st correction of research project proposal	March, 2015
1st defense of research project proposal	April, 2015
Research project proposal correction	April, 2015
Pilot-testing of research instruments	April, 2015
Data collection	May, 2015
Data analysis	May, 2015
Preparation of 1st draft of research project report	June, 2015
2nd correction of the project report	June, 2015
Final defense of the research project report	July, 2015
Final correction of research project report	July, 2015
Final submission of the research project report	July, 2015

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APPPENDIX VI: RESEARCH BUDGET

ITEM	COST (KIHS)
Typing and printing	
• Proposal	10,500
• Project	18,000
Transport	10,000
Data analysis services	5,000
Internet/library services	8,000
Miscellaneous	6000
Grand total	**57,500/=**

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APPENDIX VII: RULES AND REGULATIONS FOR IMPLEMENTING PELIS

Section 47(2) h of the Forests Act 2005 stipulates that ‘’a community forest association (CFA) authorized by the director to participate in the management and conservation of a forest or part of such a forest shall have a right to carry out plantation establishment through non-resident cultivation ‘’ among other activities.

The objective of these rules and regulations is to regulate the implementation of the PELIS scheme in forest reserves.

1. Compliance with the Forest Act.

(a). The permit holder must comply with the provisions of the forests Act 2005 and any rules made there under .Should be permit holder or his/her agents or employees commit any breach of the Forest Act or of any rules made there under, he/she will have committed an offence and will render the permit liable to cancellation or any other penalty imposed by the director in accordance with the forest act 2005.

2. Eligibility for cultivation

(a).All cultivators must be residents of areas adjacent to the forest stations and be members of a registered community forest association.

3. Demarcration of plots

a) Forest zonation and mapping will be done to identify the forest areas suitable for cultivation.
b) The individual plots will be demarcated by the area divisional forest officers, be numbered and put on a sketch map.
c) The sketch maps shall be displayed on the station notice boards.
d) A site –specific management plans will be complied for each forest station implementing PELIS.

4. Allocation method

a) Implementation will be through CFA management committees, consisting of representatives of cultivators.
b) A ballot system will be used in all cases during allocation of plots.
c) All participating CFAs must sign an agreement form before cultivation commences
d) All selected cultivators must obtain a permit before cultivation commences.

5. Crops to be crown

a). Only maize, beans (non-climbers), potatoes, carrots, peas, onions Dania, Chilles, amaranths and cabbages shall be planted in PELIS scheme. The service may review the crops to be grown from time to time.

6. Cultivator's obligations

a) The CFA leadership will ensure that none of its members or ants will take any action that will be harmful to the survival of the plated trees.
b) The cultivator shall ensure that he/she and or/his agents will not take any action that will be harmful to the survival of the planted stock. If the survival is low they will participate in either beating up or replanting, whichever is appropriate.
c) Any form of interference with the normal growth of seedlings and trees is prohibited.
d) The CFA, its agents or employees shall give assistance whenever called upon by the service in controlling illegal activities and in preventing or fighting forest fires.
e) No permit holder will be allowed to lease out or sell the allocated plot. Any attempt to lease or sell a plot will lead to the plot being reposed and plot will revert back to the service.

7. Commencement of tree planting and cultivation period

a) Planting of tree seedlings shall be done after one crop season (one year)
b) Cultivation period shall not exceed three years after tree planting. After this period, a permit holder shall vacate his/her plot.
c) Kenya Forest Service will not be obliged to allocate another plot at the expiry of 3 years period.

8. Areas restricted for cultivation

a) Cultivation shall not be allowed within the water catchment areas and slopes exceeding 30%
b) Cultivation shall not be allowed within a minimum of 30 meters on either side of river valleys and wetlands.
c) Cultivation shall not be allowed in firebreaks, roads reserves and natural forest and under plantations over 3 year old.

d) Under no circumstances shall cultivation be re-opened in plantations after expiry of the authorized 3-year period.

9. Tools and equipment for land preparation and use of fire

   Hand tools will be sued for land preparation but animals drawn equipment may be used for the initial opening up. Use of tractors and combine harvesters is prohibited.

   Use of fire in land preparation is prohibited .If the use of fire is absolutely necessary; the divisional forest officer shall give written authority, after inspection of the area.

10. Payment of shamba rent

    All cultivators will pay prevailing annual rental fees for the allocated plot before cultivation commences for that particular year.

11. Erection of temporary structures

    No residential structures will be allowed in PELIS scheme areas except in areas with high incidences of game damage. Construction of such structures shall be erected under a written permit from the director who may also issue guidelines on the number of such structures in a forest area.

12. Penalty of abuse of the system

    Any cultivator who flouts these conditions will:

    a) Lose the right to cultivate in the forest
    b) Be liable to prosecution as specified in the forest act
    c) Be liable to both (a) and (b) above
    d) Loose any crop that may be on the plot to the service

13. Areas to be opened up for cultivation

    a) The opening up of any new areas should be commensurate with the planting programme.
    b) Any opening shall only be authorized by the divisional forest officer after inspection of the area and consent from the director of KFS
    c) Plot demarcation shall be done under the supervision of the divisional forest officer.
    d) The plot sizes shall a maximum of one acre and a minimum of ½ acre.

14. Documents to be maintained

    Each station shall maintain a shamba register indicating locality, sub-

compartment number, name of cultivator, national identity card number, and receipt number, date of payment and size of plot.

A sketch map of the area under cultivation shall always be maintained, updated and be prominently displayed in the forester's office.

A register of all temporary structures shall be maintained where applicable.

15. The divisional forest officer will be held responsible for any abuse of the system.

NB: The field stations will receive all the 15 conditions but the farmer should be given the first 14 conditions translated into Kiswahili .The 14 conditions will be prominently displayed in the station notice boards.

APPENDIX VIII: DRAFT PELIS CULTIVATION PERMIT

The PELIS cultivation permit is granted to Mr./Mrs./Miss/Ms……………………….
ID NO………………………… Member of ………………………………………………….
Community Forest Association of P.O BOX …………………………………………to cultivate plot number……………………………….measuring ………………..hectares for purposes of identification marked in red and numbered accordingly on the sketch plan on this permit in Sub-Compartment Number………………………………….in ……………………….Forest Station for a period of one(1)year, subject to the following terms and conditions.

1. This permit only allows the permit holder to use plot .This permit does not make the permit –holder owner of the plot. The permit -holder has no right to sell, rent, or act as owner of plot in any way.

2. The permit-holder shall plant only annual crops on the plot. The service has a list of approved crops. The permit –holder shall choose his crops from this list and plant only annual crops.
3. The permit-holder shall help the service upon request in
   a. Beating up or replanting, whichever may be appropriate, in cases of low survival of tree seedlings.
   b. Controlling illegal forest activities
   c. Preventing or fighting forest fires and
   d. Any other activity for the benefit of the forest.
4. The permit –holder shall use hand tools to work the plot but animal drawn equipment may be used for the initial opening only.
5. The permit-holder shall not build any structure on the plot, except with written permission of the service.
6. Breaking the terms of this permit is an offence and if that happens, the service may withdraw this permit. A permit-holder who breaks the terms of this permit may be liable to other disciplinary measures.
7. The permit –holder accepts the risk of injury, harm or death from trees, logs, wild animals, game, rivers and streams, and other hazards on the plot and neighboring forest. Whether the injury happens to property, the permit-holder, or another person, the service is not responsible.

8. This permit does not give the permit holder exclusive possession of the plot or any part thereof and does not create not is it intended to create a lease or tenancy in any way whatsoever.

Signed by the Permit holder……………………Counter signed by CFA official……………

Date ………………………   Date……………………………

Name of issuing Officer………………………………………………………………………

Official Stamp …………………………………………….Date………………………

APPENDIX IX: RESEARCH AUTHORIZATION LETTER

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/0581/6469**

Date: **9th November, 2015**

Tobias Otieno Achungo
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of plantation establishment and livelihood improvement scheme on forest cover a case study of Uasin Gishu County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Uasin Gishu County** for a period ending **17th July, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Uasin Gishu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Uasin Gishu County.

The County Director of Education
Uasin Gishu County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX X: RESEARCH CLEARANCE PERMIT

THIS IS TO CERTIFY THAT:
MR. TOBIAS OTIENO ACHUNGO
of UNIVERSITY OF NAIROBI, 41-30100
eldoret,has been permitted to conduct
research in *Uasin-Gishu County*

on the topic: *INFLUENCE OF PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME ON FOREST COVER A CASE STUDY OF UASIN GISHU COUNTY KENYA*

for the period ending:
17th July,2016

Permit No : NACOSTI/P/15/0581/6469
Date Of Issue : 9th November,2015
Fee Recieved :Ksh 1,000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 7122

CONDITIONS: see back page