CONTRIBUTIONS OF PARTICIPATORY FOREST MANAGEMENT PRACTICES TO FOREST COVER AND LIVELIHOODS IN LEMBUS FOREST ECOSYSTEM, BARINGO COUNTY, KENYA

BY

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DECLARATION

Declaration by Candidate

I declare that this thesis is my original work and has not been presented for degree or any other awards in this or any other University.

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DEDICATION

I dedicate this achievement to Almighty God for giving me the gift of life. His continued support in life is wonderful. To my parent: Mr. Joseph Ondeng Awiti and Mrs. Isabella Achieng Ondeng. You are a great gift in my life. You unconditional and support is inspirational. I pay my special tribute to my late sister and close friend Margret Adoyo Ondeng. Continue resting in peace.

ABSTRACT

Globally, forests and its resources have supported the expansion of many economies with a direct employment of about 2 billion people. Recent studies show a drastic fall in the global and local forest cover to 30% and 7% respectively, subsequently leading to review of forestry legislations to address declining forest cover. In Kenya, degradation of forests has been attributed to the exclusion of forests adjacent communities in its management with the authorities. This subsequently led to enactment of the Forest Act, 2005 which provided for participation of local communities through Plantation Establishement and Livelihood Improvement Scheme. However, the contributions of PELIS to forest cover and livelihoods improvement have not been established. Therefore, the objectives of this study were to: determine the contribution of PELIS (Number of seedlings planted) on Forest cover; determine the contribution of PELIS (Forest product yields) on Forest cover; determine the contribution of PELIS (Forests products income) on the livelihood; determine the cost and benefits of PELIS; and determine the contribution of policy and legislations on livelihood, forest cover and equity in Lembus Commnity Forest Association. Cross sectional descriptive research design was adopted. Purposive sampling was used to select the 8 Commnity Forest Associations, while systematic sampling was used to select 384 households. Primary sources of data involved administration of questionnaires, Key informant interviews, Focused Group Discussions. Secondary data were collected by review of pieces of legislations and policy documents. Data analyses was done by use of both descriptive and inferential statistics. The study established a very strong positive correlation between the number of seedlings planted and forest cover which was statistically significant ($\rho = 0.934$, $p < .001$). This indicated large effect size and hence very large contribution of PELIS to forest cover. The relationships between maize and beans yields and forest cover showed a strong positive association ($\rho = 0.646$, $p < 0.001$). This indicated a large effect size and hence large contribution of PELIS to forest cover. However, maize and beans incomes showed moderate positive relationship with both school transition and livelihood projects in 2019 ($r = 0.464$, $p > 0.24$), also for beans income in 2019 ($r = 0.238$, $p > 0.05$) and herbs income in 2019 ($r = 0.265$, $p > 0.05$). These results indicated medium effect size and hence medium contribution of PELIS to livelihood. The findings further indicated that the difference between the mean cost and benefits of PFM was statistically significant, ($t(28) = 2.213$, $p<.05$). Analysis of policy and legislative awareness showed a significant number of the forest community were unaware of existing laws and policies governing tree planting, livelihood and equity ($p<.05$). In conclusion, the study found out that participatory forest management practices had positive contribution to both forest cover and livelihood, however, the consumption of forests product was imbalanced among the stakeholders. The majority of community forest association members were unaware of laws and policies governing tree planting, livelihood and equity. Therefore, there was need to increase plantation and crop production to contribute positively to forest cover and livelihood projects. The findings therefore would enable the Government to formulate laws and regulations that govern the sustainable management of forests and its resources**.**

TABLE OF CONTENTS

DECLARATION ii

ACKNOWLEDGEMENT iii

DEDICATION iv

ABSTRACT v

TABLE OF CONTENTS vi

LIST OF ABBREVIATIONS AND ACRONYMS xiii

WORKING DEFINITION OF TERMS xv

LIST OF TABLES xviii

LIST OF FIGURES xviii

LIST OF PLATES xxiii

CHAPTER ONE: INTRODUCTION 1

1.1 Background to the Study 1

1.2 Statement of the Problem 8

1.3 Objective of the Study 9

1.4 Research Questions 9

1.5 Justification/Significance of the Study 10

1.6 Scope and Limitations of the Study 10

CHAPTER TWO: LITERATURE REVIEW 11

2.1 Introduction 11

2.2 Contribution of Community Forests Association to Livelihood Improvement 11

2.3 Participatory Forests Management as Management Tool in Kenya 13

2.4 Contribution of Participatory Forests Management to Forest Cover 14

2.5 Benefit Sharing in Forest Resources 16

2.6 MajorForests Ecosystems in Kenya 20

2.7 Policy and Legislations on Participatory Forest Management in Kenya 24

2.7.1 Legislations Influencing Forest Cover in Kenya 25
2.7.1.1 The Forests Act, 2005 25
2.7.1.2 Environment Management and Coordination Act (EMCA, 1999) 29
2.7.1.3 Agriculture (Farm Forestry) Rules, 2009 29
2.7.1.4 The Constitution of Kenya, 2010 30
2.7.1.5 The Kenya Vision 2030 30
2.7.1.6 The Medium-Term Plan III (2018-2022) 30
2.7.1.7 The Forests and the Big 4 Agenda 31
2.7.1.8 The Wildlife Policy, 2011 31
2.7.1.9 Sessional Paper No. 3 of 2009 on National Land Policy 31
2.7.1.10 The Sessional Paper No. 1 of 2017 on National Land Use Policy 31
2.7.1.11 Influence of Other Policies on Tree Cover Improvement in Kenya 32
2.7.2 Legislations Influencing Livelihood within Forested Ecosystems in Kenya 33
2.7.2.1 The Forest Act, 2005 33
2.7.2.2 The Natural Resource (Benefit sharing) Bill, 2018 34
2.7.2.3 Environmental Management and Coordination Act (EMCA, 1999) 34
2.7.2.4 Other Legislations that Support Livelihood in Kenya 34
2.7.3 Legislations Influencing Equity in Plantation Establishment and Livelihood Scheme .. 35
2.7.3.1 The Forests Act, 2005 35
2.7.3.2 Natural Resource (Benefit) sharing) Bill, 2018 36
2.8 Change Detection in Forest Cover 36
2.9 Theoretical Framework – Tragedy of the Commons 37
2.10 Theories on Forest Resource Use Conflict 38
2.11 Conceptual Framework of the Study 39
CHAPTER THREE: RESEARCH METHODOLOGY 41
3.1 Introduction 41

3.2 Description of Study Area 41
3.2.1Geographic Location and Size 41
3.2.2 Forest Cover in Lembus Forest Ecosystem 42
3.2.3 Forest blocks in Lembus Ecosystem 43
3.2.3.1 Chemorgok Forest Block 43
3.2.3.2 Chemususu Forest Block 43
3.2.3.3 Esageri Forest Block 44
3.2.3.4 Kiptuget Forest Block 44
3.2.3.5 Koibatek Forest Block 44
3.2.3.6 Maji Mazuri Forest Block 44
3.2.3.7 Narasha Forest Block 45
3.2.3.8 Sabatia Forest Block 45
3.2.4 Climatic Conditions 45
3.2.5 Topography 45
3.2.6 Participatory Forest Management Plans 45
3.2.7 The Socio Economic Activities 46
3.2.8 Road Networks 46
3.2.9 Poverty Level 46
3.2.10 Criteria used in Selection of the Study Area 47
3.3 Research Design 47
3.4 Target Population 47
3.5 Sampling Techniques 47
3.6 Data collection Procedures 48
3.6.1 Primary Sources of Data 49
3.6.1.1Measurement of Forest Cover 49
3.6.1.2 Questionnaires 49

3.6.1.3 Focused Group Discussions (FGDs) 49
3.6.1.4 Key Informant Interviews 49
3.6.2 Secondary Sources of Data 49
3.7 Data Analyses 50
3.7.1 Pilot Testing and Reliability of the Questionnaire 52
3.7.2 Research Ethics 52
CHAPTER FOUR: RESULTS AND DISCUSSIONS 53
4.1 Introduction 53
4.2 Contribution of PELIS (Number of Tree Seedlings Planted) to Forest Cover in Lembus Forest Ecosystem 53
4.2.1 Size of Forest Planted (Forest Cover) under PELIS in 8 forest blocks in Lembus Forest Ecosystem 53
4.2.2 Number of Tree Seedlings Planted in 8 Forest Blocks under PELIS in Lembus Forest Ecosystem 54
4.2.3 Association between Number of Tree Seedlings Planted and Forest Cover (Size of Forest Planted) in Lembus Forest Ecosystem 55
4.3 Contribution of PELIS (Forest Products Yields) to Forest Cover in Lembus Forest Ecosystem 57
4.3.1 Maize yields Obtained in Eight Forest Blocks under PELIS in Lembus Forest Ecosystem 57
4.3.2 Bean Yields Obtained In Eight Forest Blocks under PELIS in Lembus Forest Ecosystem 57
4.3.3Association between Annual Maize Yields and Size of Forests Planted (Forest Cover) 58
4.3.4 Association between Annual Bean Yields and Size of Forests Planted (Forest Cover) . 60
4.4 Contribution of PELIS (Forests Products Income) to the CFA Livelihoods in Lembus Forest Ecosystem 62

4.4.1 Forest Products Income in Lembus Forest Ecosystem 62
4.4.1.1Maize Income Obtained for the Years 2015 To 2019 in Lembus Forest Ecosystem ... 62
4.4.1.2 Beans Income Obtained for the Years 2015 to 2019 in Lembus Forest Ecosystem 63
4.4.2 Livelihood Projects under PELIS in Eight Forest Blocks in Lembus Forest Ecosystem 64
4.4.2.1 Students Transition from Primary to Secondary Schools 64
4.4.2.2 Construction of commercial buildings and boreholes 65
4.4.2.3 Income Obtained from Medicinal Herbs for the Years 2015 to 2019 in Lembus Forest Ecosystem 66
4.4.3Association between Forest Products Income and Livelihood Projects 66
4.4.3.1Association between Maize Income and Students' Transition 66
4.4.3.2 Association between Maize Income and Construction of Commercial Buildings and Boreholes 68
4.4.3.3 Association between Beans Income and Students Transition..... 70
4.4.3.4 Association between Beans Income and Commercial Buildings and Boreholes 71
4.4.3.5Association between Income from Medicinal Herbs and Students Transition..... 73
4.4.3.6 Association between Income from Medicinal Herbs and Commercial Buildings and Boreholes 74
4.5 Costs and Benefits Analysis in Plantation Establishment and Livelihood Improvement Scheme in Lembus Forest Ecosystem..... 76
4.5.1 Allocation of Glades for PELIS 79
4.5.2 Production Input..... 80
4.6 Level of Awareness of Policy and Legislations on Forest Cover, Livelihood and Equity 83
4.6.1 Analysis of Forest Cover Legislations 83
4.6.1.1 The Forests Act, 2005 83
4.6.1.2 Environment Management and Coordination Act (EMCA, 1999) 85
4.6.1.3 Agriculture (Farm Forestry) Rules, 2009..... 86

4.6.1.4 The Constitution of Kenya, 2010 86
4.6.1.5 The Kenya Vision 2030 87
4.6.1.6 The Medium-Term Plan III (2018-2022) 87
4.6.1.7 The Forests and the Big 4 Agenda 88
4.6.1.8 International Conventions and Obligations 89
4.6.1.9 The Wildlife Policy, 2011 89
4.6.1.10 Sessional Paper No. 3 of 2009 on National Land Policy 90
4.6.1.11The Sessional Paper No. 1 of 2017 on National Land Use Policy 91
4.6.1.12 National Policy for Disaster Management 91
4.6.1.13The National Water Policy of Kenya, 1999 92
4.6.1.14 The National Biodiversity Strategy of 2000 92
4.6.1.15 Summary of Policy and Legislative Strengths on Tree Cover in Lembus Ecosystem 93
4.6.2 Legislations that Influence Livelihood in Forested Ecosystems 94
4.6.2.1 The Forest Act, 2005 94
4.6.2.2 The Natural resource (Benefit sharing) Bill, 2018 95
4.6.2.3 Environmental Management and Coordination Act (EMCA, 1999) 95
4.6.2.4 Agriculture (Farm Forestry) Rules, 2009 96
4.6.2.5 The Constitution of Kenya 96
4.6.2.6 International Conventions and Obligations 97
4.6.2.7 Sessional Paper No. 10, 2014 on the National Environment Policy 97
4.6.2.8 Sessional Paper No. 3, 2009 on National Land Policy 98
4.6.2.9 The influence Equity in Forests Resource Sharing in Forested Ecosystem 99
4.6.2.10The Forests Act, 2005 99
4.6.2.11 Natural resource (Benefit) sharing) Bill, 2018 100

4.6.2.12 Chi Square analysis on Consistency of Awareness on Policy and Legislation Gaps 102

4.6.2.13 Chi Square analysis to test on Consistency of Unawareness on Policy and Legislations Gaps.....104

4.6.2.14 Chi Square analysis on relationship between Awareness and Unawareness on Policy and Legislative Gaps.....105

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS.....106

5.1 Summary of Findings.....106

5.2 Conclusions.....108

5.3 Recommendations.....109

5.4 Areas for Further Study 110

REFERENCES.....111

APPENDICES.....124

LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	One-Way Analysis of Variance
ATR	African Traditional Religion
CANARI	Caribbean Natural Resources Institute
CAP	Chapter
CBNRM	Community Based Natural Resource Management
CFA	Community Forest Association
CFM	Community Forest Management
CIDP	County Integrated Development Plan
DENR	Department of Environment and Natural Resources
DFRD	District Focus for Rural Development
DRSRS	Department of Resource Surveys and Remote Sensing
FCMA	Forest Management and Coordination Act.
GoK	Government of Kenya
GoU	Government of Uganda
GRN	Government of the Republic of Namibia
GTZ	German Technical Development Co-operation
IFAD	International Fund for Agricultural Development
JFM	Joint Forest Management
JICA	Japanese International Co-operation Agency
KFMP	Kenya Forestry Master Plan
KFS	Kenya Forest Service
KFWG	Kenya Forests Working Group
KLA	Kenya Land Alliance
MENR	Ministry of Environment and Natural Resources
NEMA	National Environment Management Authority

NTFP Non-Timber Forest Product

PELIS Plantation Establishment and Livelihood Improvement Scheme

PFM Participatory Forest Management

PFMP Participatory Forest Management Plan

UNCED United Nations Conventions on Environment and Development

WSSD World Summit for Sustainable Development

WORKING DEFINITION OF TERMS

Agriculture Act, Cap 318 (Farm Forestry) Rules 2009: These were guidelines made ministry of Agriculture to ensure a 10% holding tree cover holding capacity in farms.

Benefit sharing in natural resources: This refers to engagement of all stakeholders to have equal opportunity in consumption of natural resources e.g. forests.

Community forest association: These are forests riparian communities who are registered and allowed to cultivate inside the forests by the forests authorities.

Condition of forest ecosystem: Refers to quality and quantity of forest ecosystem i.e. rate of erosion and deforestation of a forest area.

Equity and benefit sharing of forest resources: Equal and agreeable distribution or allocation of forest products and services to stakeholders.

Forest Act, 2005: This is a piece of legislation that provides for Community participation in forests resource management in Kenya.

Forest Crop Farming: This refers to integration of crops (maize and beans) and trees (*Cupressus lusitanica* and *Pinus patula*) in same piece of land in the forest area.

Forest ecosystem services: These goods and services can be obtained from a functional forest ecosystem.

Forest ecosystem: This is a natural woodland of all plants, animals and microorganisms functioning together.

Forest cover: This is the amount of forested land whose tree canopy cover exceeds 10%. In this study, it was measured by area of land under forest cover.

Forest Products income: These refers to amount of money obtained from selling maize, beans, herbs and fuel wood produced in the forest. Further, it refers to all trees sold under PELIS.

Forest plantation establishment: This are trees planted alongside beans or maize within the forest under PELIS framework.

Forest Products Yields / Production: These refers to amount or quantity of maize, beans, herbs and fuel wood, produced inside the forest. It also refers to all trees planted under PELIS programme and their contribution to forest cover.

Forest: This is a group of trees within a terrestrial ecosystem having 15% canopy cover with at least 2-meter tree height.

Fuel wood collection: Collection of wood that is harvested from forestlands by people living in areas adjacent to forests. In this study, it was measured in Kilograms.

Gazzeted forest: Land areas of forests that have been surveyed demarcated and published by Government in the Kenya Gazette and its management is bestowed to the Forest Authorities.

Income sources: This refers to areas through which the community derives their livelihood from the forests (firewood collection, charcoal burning and crop production).

International conventions and obligations: Are formal agreements between States, otherwise known as treaties, and are part of international law. That create binding obligations for member States to forge a common agenda on environment.

Kenya Vision 2030 on Forest: This a forest conservation and management policy that is geared towards realizing economic growth in Kenya.

Livelihood: This refers to set of activities that support students' education, establishment of business and commercial buildings etc. It was measured in terms of 40% and 42% net income allocated to students' fees and costs for infrastructure development respectively.

Livelihood projects: These are activities supported from proceeds of PFM (PELIS, Firewood and Medicine income). They include Educational (students' transition), Business, and Commercial premises.

Medicinal herbs collection: This is an activity under PFM user right, where herbs are extracted from the plant. In this study, it was measured amount collected and sold.

Medium Term Plan III (2018-2022): A GoK Blue Print that operationalizes the Vision 2030 plans into Sectoral targets, with forest expected to attain 10% forest cover by 2030.

Natural Resource (Benefit Sharing) Bill, 2018: The legislation, which promotes equal and equitable access to the resource consumption by host communities and the resource authorities.

Net income levels: This refers to amount of money earned from forest product and services (selling firewood, selling charcoal, selling agricultural products, honey, etc.).

Participatory forest management: Involvement of local community and forest authorities in a joint management of forests to foster increased forest cover and improvement livelihood. In this study PFM is defined in terms of its user rights such as PELIS (forest plantation and crop farming), Firewood income Medicinal Herbs income.

Partcipatory forest management practices: These are activities lisenced by Government to be undertaken by the CFA members like PELIS, firewood collection etc.

Plantations Establishment and Livelihood Improvement Scheme. This is a forest management tool where registered forest community members grow crops in the forests while tending seedlings planted. In this study, it refers plantation establishment (trees planted), crops raised (maize and beans) and income and yield arising from them.

Sessional Paper Number one of 2017 on National Land Use Policy: The advocates for environmental protection and management for enhanced socio economic productivity.

Sessional Paper Number three of 2009 on National Land Policy: This Sessional Paper was premised on the reduction of environmental degradation as a measure to address social justice in the community. In this study, it provides an opportunity to be used to improve tree cover.

Sustainable forest management: Production of goods and services in a constant supply regime without disruption for present and future generations.

User rights: These are licensed activities by the forest authority to the Community Forest Association members to utilize forest resources. In this study, it refers to PELIS, fuel wood and herbs collection.

Wildlife Policy, 2011: This entails among others animals' settlement under trees and a need to protect such habitat through conservation of such resources and tree planting programme

LIST OF TABLES

Table 1: Community Forest Associations (CFA) in eight forest blocks, number of households and the sample size……48

Table 2: Size of forests planted (forest cover) under PELIS from 2015 to 2019 in eight forest blocks in Lembus forest ecosystem……53

Table 3:The Number of Tree Seedlings Planted by CFA under PELIS for the Years 2015 to 2019 in Eight Forest Blocks in Lembus Forest Ecosystem……54

Table 4: Pairwise Spearman Rank correlation coefficients p between numbers of seedlings planted under PELIS and size of forest planted in hectares (forest cover) in eight forest blocks in Lembus forest ecosystem……56

Table 5: Mean annual maize yields (Kg) received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019……..…57

Table 6: Mean annual bean yields (Kg) received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019…….….58

Table 7: Pairwise Spearman rank correlation coefficients p between size of the forest planted and annual mean maize yields for the years 2015 to 2019 in eight forest blocks in Lembus forest ecosystem……59

Table 8: Pairwise Spearman rank correlation coefficients p between size of the forest planted and annual mean beans yields for the years 2015 to 2019 in eight forest blocks in Lembus forest ecosystem……61

Table 9: Mean annual maize income in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019……...63

Table 10: Mean annual beans income in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019……64
Table 11: Number of students who transited from primary to secondary schools supported by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019…….64
Table 12: Number of commercial buildings and boreholes constructed which were supported by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019…….65
Table 13: Mean annual income from medicinal herbs in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019…….66
Table 14: Pairwise Spearman's rank correlation coefficients between maize income and school transition in eight forest blocks for years 2015 to 2019 in Lembus forest ecosystem……67
Table 15: Spearman Rank correlation coefficients p between mean annual maize income and number of commercial buildings and boreholes constructed for the years 2015 to 2019……69
Table 16: Pairwise Spearman's rank correlation coefficients between beans income and school transition……..70
Table 17: Spearman's rank correlation between beans income and commercial buildings and boreholes…….72
Table 18: Spearman's rank correlation between income from herbs (medicine) among the CFAs (Kshs) and school transition…….73
Table 19*:* Spearman Rank correlation coefficientsp between income from medicinal herbs and commercial buildings and boreholes……75

Table 20: Estimated value of Benefits from PELIS in Kenya Shillings (Kshs) for the years 2015 to 2019……...……76

Table 21: Estimated Costs of implementing PFM for the years 2015 to 2019……77

Table 22: T-Test results comparing Estimated Cost and Benefits of PFM……..…77

Table 23: Level of Awareness on Forest Act, 2005 and related Amendments……..…….…83

Table 24: Level of Awareness on EMCA, 1999 and related Amendments…….……84

Table 25: Level of Awareness on Agriculture (Farm Forestry) Rules 2009…….....85

Table 26: Level of Awareness on the Constitution of Kenya, 2010……....86

Table 27: Level of Awareness on the Kenya Vision 2030……..…….,,,…..86

Table 28: Level of Awareness on the Medium-Term Plan III (2018-2022)…….,,,…….87

Table 29: Level of Awareness on the Forests and the Big 4 Agenda……..88

Table 30: Level of Awareness on International conventions and obligations……...…..88

Table 31: Level of Awareness on the Wildlife Policy, 2011……...89

Table 32: Level of Awareness on Sessional Paper No. 3 of 2009 on National Land Policy...89

Table 33: Level of Awareness on National Land Use Policy……..…90

Table 34: Level of Awareness on National Land Use Policy (NLUP)……...….91

Table 35: Level of Awareness on the National Water Policy of Kenya 1999…….91

Table 36: Level of Awareness on the National Biodiversity Strategy of 2000……....92

Table 37: Analysis of Awareness of various legislations on forest / tree cover……..…92

Table 38: Level of Awareness on Forest Act, 2005 and related Amendments on livelihood..93

Table 39: Level of Awareness on the Natural resource (benefit sharing) Bill, 2018 on livelihood……..……..94

Table 40: Level of Awareness on Environmental Management and Coordination Act, 1999 on livelihood……..……95

Table 41: Level of Awareness on Agriculture (Farm Forestry) Rules 2009……....95

Table 42: Level of Awareness on the Constitution……..…96

Table 43: Level of Awareness on International Conventions and Obligations……..…..96

Table 44: Sessional Paper No. 10 of 2014 on the National Environment Policy…….....97

Table 45: Level of Awareness on Sessional Paper No. 3 of 2009 on National Land Policy...97

Table 46: Summary of Policy and Legislative strengths on awareness on livelihood support projects……....98

Table 47: Forests Act, 2005 influence on Equity and benefit sharing……..……..99

Table 48: Natural resource (benefit) sharing) Bill, 2018 on Equity and benefit sharing…...100

Table 49: Analysis of Awareness of various legislations on Forest Resource Sharing…….101

Table 50: Level of awareness (%) among CFAs……....102

Table 51: Factors affecting awareness on environmental legislations among CFAs…….103

Table 52: Level of Unawareness on Policy and Legislations.....103

Table 53: Level of Awareness and Unawareness on Policy and Legislations among CFAs.104

LIST OF FIGURES

Figure 1: Conceptual Framework 40

Figure 2: Maps showing the distribution of the eight forest blocks forming the Lembus forest ecosystem and Lembus forest ecosystem within Mau Complex. 42

Figure 3: Lembus forest cover 2007 – 2016 43

Figure 4: Approval rating for PELIS 78

Figure 5: Approval rating for Shamba System 79

Figure 6: Approval for PELIS allocation in the forests 80

Figure 7: Rate of fertilizer application 80

Figure 8: Tendering procedure for forest logging 81

Figure 9: Livelihood Projects supported through forest proceeds by forest authorities 82

Figure 10: Principles of forest resource allocation 82

Figure 11: Proposed ways of sharing forests resources 83

Figure 12: Awareness on Equity legislations in Kenya 102

LIST OF PLATES

Plate 1: Consultation with Chemususu CFA members 124

Plate 2: Forest allocated for beans growing within Sabatia forest 124

Plate 3: Focus Group Discussion with Sabatia CFAs 125

Plate 4: Consultation with Maji Mazuri CFA members 125

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Globally, forests cover had reduced by 30% due to high human population growth and expansion of agricultural production (Sam and Shepherd, 2011; Keena, *et al*., 2015). Studies had showed that about four hundred million people are vulnerable to deficiencies arising from forests and its products while a whopping two billion others directly rely on it for livelihood provision (Munan et *al*., 2011). This therefore required participatory approaches to conserve the remaining forests resources to reverse the situation (Crespo *et al.*, 2017). Africa which had about 22% of land mass accounting for forests, have major issues of forest governance and was slowly introducing participatory approaches to address rapid forest degradation (Achard*et al*., 2014). In Kenya, the forests cover currently stands at about 7.3%, with about 115 Forest Management Plans developed to comply with Forest Conservation and Management Act, 2016 (GoK, 2018). However, the country is yet to transit to 10% forest cover threshold despite policy and legislative reforms undertaken in the forestry sector.

Due to continued forests ecological deterioration and global threat to food security, the United Nations General Assembly in 1989 called for meeting to develop mitigation measures to address rising anthropogenic threats into the environment by promoting sustainable developments across the world (United Nations, 2023). This subsequently led to the enactment and operationalisation of laws and policies focusing on participatory forest management approaches around the globe in compliance with the Rio resolutions (United Nations, 2011). At the global front, a number of countries including India, adopted policies to regulate forest logging in a deliberate effort to operationalise of the Rio Summit resolutions, however, these efforts suffered financial resource constraints hence leading to the continued deterioration of forest ecological infrastructure (Maikhuri *et al.*, 2020). Subsequently, many countries, especially in Sub Saharan Africa, enacted new laws to operationalise participatory forest management approaches (Saxena *et al.*, 2021) in compliance with the Rio resolutions. This was meant to anchor PFM within the legal framework for sustainability with a call to involve the community.

In countries like Nepal, PFM was meant to address deforestation and degradation of forests, however, the Government lacked enough capacity to address the challenges while in China,

sharing of PFM benefits to the community was never a priority because the forest resources were managed by the State (Springate-Baginski et *al.,* 2007). In the two findings, PFM was meant to address deforestation challenges through legal and policy reforms and distribution of benefits. Socio economic challenges within rural Nepal and India were the driving factor behind PFM (Thomas *et al*., 2024). Similarly, in Honduras and Bolivia, the government had to fully involved community participation to improve the quality of their livelihood (Nygren, 2025), but Fedau *et al.,* (2021) reported that there was inadequate information on the influence of participatory approaches on local community livelihood. The overall objective was to devolve forest management from the centralized authority to local people to improve their livelihood. Contrastingly, Fedau, (2021) found out that there were glaring gaps in measuring forests livelihood resources despite Nygren's (2025) findings that the PFM would improve the local livelihood. The two studies (i.e. Fedau *et al*., (2021) and Nygren's (2025) were in agreement that there was a positive effect of PFM i.e. forest farming on the livelihood, however measuring its influence on the livelihood posed some difficulty that required a determination.

Regionally, it had been reported that there was lack of verifiable data on actual benefits PFM offered to the community, especially in Uganda (Driciru, 2011). This therefore resulted into forests resource destruction and unsustainable exploitation through unregulated silvicultural operations like logging, pruning and thinning (Driciru, 2011). Assembe *et al.,* (2016) and Bigombé, (2020) also confirmed that the livelihood of the forest communities in Cameroon had not changed significantly since the introduction of PFM. This was attributed to poor governance leading to resource mismanagement. In contrast, Driciru, (2011); Assembe`*et al.,(*2016); Bigombé (2020) and Saxena *et al*., (2021) were in agreement that PFM approaches had resulted into positive influence on livelihood of local forest communities, a function of equal access and opportunities in the consumption. However, none of them did provide any measurable information on PFM's influence on the livelihood.

According to Scher *et al.,* (2007), efforts had been made to monitor the quantity and quality of PFM to communities, but the real benefits arising to local communities under the PFM as a tool were scanty, with limited information regarding its influence on the livelihood of the forests communities. Catherine *et al.,* (2017), also found out that the impact of poverty alleviation through the introduction of PFM had been largely unknown in the last two decades.The two

studies i.e. Saxena, *et al.,* (2021) and Scher *et al.,* (2007) therefore, confirmed that livelihood status due to PFM was still not known. In other studies, i.e. Kaimowitz, (2003); World Bank, (2004); Sunderlin *et al.,* (2005) and FAO, (2008), reported that rural households within forested ecosystems in many developing countries generate cash income to support livelihood programmes. However, other researchers found out that participatory forest management income made significant contributions to livelihood in most rural settings (Arild *et al.,* 2014).However, according to Ongugo *et al*., (2012) there was a lot of socio-economic data still missing on how forest influenced the livelihood and overall Gross Domestic Products of the respective countries. It is therefore important to note that both Arild *et al*., (2014) and Ongugo *et al*., (2012) were in agreement that forest contributed significantly to livelihood in most rural settings, but there was no data to support the argument. There was therefore a need to determine the extent to which forest farming (PELIS) contributed to the livelihood of the CFA members.

Lack of funding had been cited as an obstacle to success of PFM in Africa. According to Winberg, E. (2010), participatory forest initiatives still faced financial unsustainability and its impact on poverty reduction remained unclear. According to Cavendish, (2014), there had been a glaring gap on the socio economic contribution of PFM in Zimbabwe. Both studies point a clear indication of an existing gap of the economic influence of FPM on the community's livelihood. This was also supported by Scher *et al.,* (2004) and Cavendish, (2014) findings that there was an existing gap in the economic status of the communities. Senganimalunje, (2016) also found out that the contribution of PFM to national economic development and poverty reduction was found out to be on a positive trajectory, but the amount of its contribution was still undocumented. This showed an indication of an existing gap on the economic significance of PFM on consumers that required further determination.

Contribution of PFM on the forest cover had varied scholarly results, with majority showing positive influence. Studies done under these investigations had shown increased forest cover attributed to community involvement (*Tesfaye, et al.,* 2024). Forest farming had a capacity to restore functionality of degraded landscapes due to climatic or anthropogenic disturbances. However, despite these findings, information was still lacking to show the measurable contribution through forest farming (PELIS) (Scher *et al*., 2009). Such findings form a better ingredient of legal and policy formulation to intervene in threatened forests ecosystems. Studies

done by Beck, (2000) found out that high community participation in PFM activities resulted into reduced cases of illegal activities hence leading to tree quality thus resulting to increased forest cover. Participatory approach had been used as tool for forest resource management, but there has been a lack of supportive data on its influence on the ecosystem and this was a gap that required a determination.Participatory forest management was found to contribute to increased tree species richness and composition, potentially increasing the general forests cover (*Tesfaye, et al.,* 2024).Similarly, according to Scher *et al*., (2009), a lot of information was not yet available on the extent of PFM contribution to forests cover increment through regulated forest area access and utilization. From the two research findings, the first one appreciated the positive effects of PFM on forests cover while the second reported lack of information to support its contribution to the forest status. This therefore called for a determination on how the forest farming contributed to the forest cover improvement.

In other related studies carried out to investigate the influence of participatory approaches in Bonga Forest, Ethiopia, it was found that there was significant improvement of forest conditions through natural forest regeneration and increased vegetation cover showing a healthy population distribution across the forest ecosystem (*Tesfaye et al.,* 2024). This was attributed to cooperation of the local communities and the forests authorities within the framework of empowerment, capacity building and decision making process (*Tesfaye et al., 2024).* These findings confirmed results of similar studies done in other countries like in Tanzania where PFM recorded improved forest quality with a functional ecosystem attributes (Kajembe *et al.,* 2005). According to Prasad *et al*., (2023), similar results were also recorded in most parts of India, like Gujarat, Andhra Pradesh, Haryana, Madhya Pradesh and West Bengal, where the forest ecosystem achieved maximum functionality through productivity and diversity. There was concurrence i.e. Kajembe *et al.,* (*2014*); Prasad, (2023); and *Tesfaye et al.,* (*2024*) *that PFM* could potentially increase vegetation cover, however there was lack of information in terms of forest size that had a direct influence from PELIS. This therefore required a determination on the effects of PFM on forest cover under the local socio economic, ecological and cultural considerations.

In Kenya, studies showed that there was an increment of area under PELIS in some selected zones in the Rift Valley between 2011 to 2013, but the amount of seedlings survival resulting into forest cover increment was not documented (KEFRI, 2014). GoK, (2011) further reported

that PELIS was systematically abused by encroachment into indigenous forest and other critical biodiversity hot spots, thus resulting into low quality plantations. Agevi *et al.,* (2006) also reported an increase in forest cover under plantations in Malava forest in Western Kenya. While Agevi e*t al.,* (2006) and KEFRI, (2014) and appreciated the positive influence of PFM on forest cover improvement, GoK, (2011) report provided contradictory results. This therefore, required a further investigation to find out the real influence of PFM on forest cover improvement.

Equity and resource sharing of forest resources had been misunderstood in many countries globally (Pulhin and Inoue, 2022). This significantly led to the formation of participatory forests management initiatives, including forest farming (PELIS) with stronger cost sharing policies (Miyakawa *et al.,* 2018). In other jurisdictions, especially in the Caribbean, several forests law amendments were done to be participatory focused, while still embracing the centralized form of management from the national government. This therefore called for urgent policy review to realign with the Rio resolutions with greater stakeholder involvement (CANARI, 2014). On critical analysis, the studies of Pulhin and Inoue, (2022); CANARI (2014) and Miyakawa *et al*., (2010), showed that there was lack of proper legislative agenda to align management of forests and its resources on equitable consumption, even as taungya system was introduced in Latin America and forest concessions in the Asia as policies geared towards enhancing PFM (FAO, 2010). However, they failed to propose or indicate the necessary legislations to address imbalance in forest resource consumption.

Further, the destruction of forest ecosystems in Kenya led to massive degradation and deforestation of forests (GoK, 2021). This subsequently led to advocacy against destruction of forests by the civil societies leading to adoption of PFM and the resultant benefit sharing in the Forest Act, 2005 (Ghate, 2004; Ogungo, 2007). However, Ongugo *et al*., (2012) recommended that the proceeds from PFM initiatives should directly target the forests farming communities in order to balance the scales on the forests resource consumption. However, this had little effect on equitable consumption of forests resources and livelihood (Thenya *et al.,* 2007; Ongugo *et al.,* 2007and Witcomb and Doward, 2009) and this formed a wide gap that called for a further investigation on cost and benefits around PELIS among the players i.e. CFAs and the government. In summary, the three researchers confirmed that the benefit sharing issues around PELIS did not adequately address the concerns of the forest communities. While Ghate, (2004),

stressed the economic significance of benefit sharing, Ongugo *et al*., (2012) wanted the inventory of shareable forest resources. However, none of them had a suggestion on how the resources could be shared equitably and this had been the main cause of conflicts in forests resource use, especially PELIS. This therefore left a policy and legal gap on equity, forest cover and livelihood.

Many forest-based economies, especially in the developing world were constrained of public awareness on legal rights about the natural resource use and consumption. According to Ongugo *et al.*, (2007), civil society organizations voluntarily resorted to take up the role of the forest authorities in explaining the contents and implications of the new forest policy and law to the forest communities. In many jurisdictions, this had compromised public awareness and participation on ecosystem restoration (GoK, 2011), as there was lack of provision in the lawsand this therefore created a gap in the community capacity building on how their rights could be enhanced.

Reforms in the forestry sector were introduced with the principal objective of ensuring the governments devolve powers to local communities, to ensure improved livelihood, equity and tree cover increment (Tesfaye, 2024). Regrettably, the local community who had the mandate to implement the programmes were constrained of supportive policies and constantly frustrated in accessing forest resources, including Plantation Establishment and Livelihood Scheme (Saito-Jensen *et al*., 2010). Essentially, this raised issues on sharing of the forest resource proceeds as was legislatively anticipated. Elsewhere in Uganda, the Government introduced legislations that were community focused in the management of forests and its resources, however, weak legal policies to support participatory forest management plan was still lacking for the practice to succeed (Gombya-Ssembajiwe and Banana, 2010). This meant that the introduction of PFM and its intended objective was good; however, it still lacked laws and policies to achieve its objective. This definitely called for a review of the policies to be participatory focused on equity, livelihood and forest status.

According to Gombya-Ssembajiwe and Banana (2010), forest communities were supportive of conservation initiatives when given adequate incentives and ownership skills, but a working method for sharing of the resource has been missing thus leading to sustained destruction on

forest resources. In a forest conservation project in Zanzibar, Kachamba *et al*., (2009) found out that 14% of the forest proceeds was allocated to the community treasury, while 25% and 65% of the proceeds were allocated to farmers and Development Associations respectively. Though the project was highly successful, the procedure at distribution of the proceeds was not identified. Saito-Jensen *et al*., (2010) further confirmed that local communities use of the forest resources were restricted and always frustrated to access such services. There was a concurrence i.e. Saito-Jensen *et al.,* (2010) and Gombya-Ssembajiwe and Banana, (2010) that there were policy and legislative gaps that accelerated deforestation and degradation due of forests resources. This was further found out by Pulhin and Inoue, (2022); CANARI, (2014); and Miyakawa *et al*., (2018) that there were inadequacy in policies and legislations to address equity in forest resource consumption. However, in all instances, none of them provided a policy and legislative option on equity, livelihood and forest cover.

Forest concessions, incentives and benefit sharing and investor involvement in sharing the benefits accruing from forest investments with the local community were some stimulus provisions in Kenya (GoK, 1996). These were deliberate provisions geared towards improvement of forest cover and livelihood among the forest based community economies. While Ogungo *et al*., (2007) decried lack of public awareness on environmental laws, Gombya-Ssembajjwe and Banana, (2010) appreciated their existence but were weak to support participatory forest management initiatives.To determine the effectiveness of these laws and their contribution to forest cover, it therefore became necessary to assess the level of awareness on the existence of such laws and policies that address forest cover and livelihood challenges.

Progressive laws and policies had seen many countries around the globe increase their forest cover in compliance to the United Nations forest cover requirement of 10%. India for example achieved a 22% forest cover after operationalising the Forest (Conservation) Act of 1980 by the Parliament. Similarly, the reforms in the forestry sector saw countries like Nepal and India increase their forests cover to 37.4% and 24% respectively after the two countries embarked on massive landscape restoration programme. Regionally, Seychelles had recorded an impressive target of 88.9% forest cover after enacting the Forest Law in 2020. However, Kenya's progressive environment laws and policies, had sluggishly facilitated the forest cover transition to 10%, food security and equal sharing, despite being in operation for the last one and half

decade. This study therefore intended to determine the policy and legislative strengths and weaknesses that had constrained the country into attaining the UN required forest cover threshold. An analysis of environmental legislations in Kenya were geared towards improvement of forest tree cover.The Forest Act, 2005 provided for the incentives and benefit sharing. The Act further provided for National tree planting Week, International Forest Days and Forest Concessions with an objective of increasing the forest cover. The Environment Management and Co-ordinating Act (EMCA, 1999) also provided for the issuance of guidelines for achievement of a 10% forest cover and development of guidelines and regulations on sustainable management of hilltops, hillsides and wetlands. The Kenyan Constitution also provided for the attainment of a 10% forest cover. Whereas most of the African countries (Seychelles, Uganda, Cameroon) had complied with the United Nations minimum forest cover requirement at 10% (FAO, 2010), Kenya still remained behind at 7.2%, despite enacting several progressive legislations that support tree growing. It was therefore necessary to determine the effectiveness of these legislations in terms of level of knowledge and awareness amongst the local population and their implementation constraints.

In Lembus Ecosystem, the poverty index had risen to 52.12% with a forest tree cover of 24.12%. GoK, (2005) also reported that Lembus forest had been highly degraded amongst Kenyan forests and its cover had receded drastically over time. The Forest Act, 2005 anticipated improved livelihood through the PFM**.** However, increased illegal logging in the county was an indicator of a misapplication of PFM principles to yield a positive impact.

1.2 Statement of the Problem

Degradation of forests and its resources has been attributed to the exclusion of forests adjacent communities in the joint management with the forests authorities. This subsequently led to enactment of the Forest Act, 2005 which provided for participation of local communities through Plantation Establishement and Livelihood Improvement Scheme (PELIS). The principal aim was to ensure increased forest cover, improved livelihood and equity in consumption of forests resources. However, despite the introduction of PELIS, there still existed inadequate information on how PELIS improved the forest cover in Lembus Ecosytem. Secondly, the contribution of the yield arising from PELIS on forest size had not been documented in order to assess its influence. Further, there had been lack of data and information on how PELIS contributed to improvement

of community livelihood even as the poverty levels remained high in the study area. Cases of conflicts around equitable consumption of forests resources, especially PELIS had been on the rise. This was attributed to lack of information on costs and benefits of PELIS between the stakeholders. Finally, the community participation and awareness on existing laws and policies on forest cover, livelihood and equity had not been assessed to identify gaps for intervention. Studies done globally, regionally and locally in Kenya had shown varied results with little information on the measure of livelihood and the extent of forest cover improvement. Lembus forests in Baringo County, was among those forests in Kenya which had been adversely affected by agricultural and anthropogenic activities, thus impairing both ecological and economic services of the foreststo the dependent communities.

1.3 Objective of the Study

The overall objective of the study was to assess the contributions of participatory forests management practices (Plantations Establishment and Livelihood Improvement Scheme, PELIS) to forest cover and livelihoods in Lembus forest ecosystem, Baringo County, Kenya.

The specific objectives were:

i. To determine the contribution of PELIS (Number of seedlings planted) to forest cover in Lembus forest ecosystem.
ii. To determine the contribution of PELIS (Forest product yields) to Forest cover in Lembus forest ecosystem.
iii. To determine the contribution of PELIS (Forests products income) to the CFA Livelihoods in Lembus forest ecosystem.
iv. To analyze the costs and benefits of Plantation Establishment and Livelihood Improvement Scheme on CFAs in Lembus forest ecosystem.
v. To determine the level of awareness of policy and legislations on forest cover, livelihood and equity in Lembus forest ecosystem.

1.4 Research Questions

i. How does the PELIS (Number of seedlings planted) contribute to forest cover in Lembus Forest ecosystem?
ii. How does PELIS (Forest product yields) contribute to forest cover in Lembus forest ecosystem?

iii. How does PELIS (Income from forest products) contribute to CFA livelihoods in Lembus forest ecosystem?

iv. What are the cost and benefits in participatory plantation establishment and livelihood improvement scheme in Lembus forest ecosystem?

v. What is the level of awareness to the policy and legislations of livelihoods, forest cover and equity?

1.5 Justification/Significance of the Study

The study put emphasies on how plantation establishment within PELIS framework could influence tree cover and livelihood. The output of this investigationwould enable the Government to develop policies and legislations that accelerate forest cover increment through Regulations and Guidelines. The outcome would further be used by the Government as a tool todevelop strategies and interventions leading to policy formulation on food production**.** The outcome on Cost Benefit Analysis of the participatory forest management would enable the Government also to develop Forest Use Guidelines or Benefit Sharing Regulations. The Government would further use the outcome of this study to develop policies to govern consumption of the resources equitably and sustainably. Finally, the Government would use the outcome to develop Policies or Regulations on Public Participation on Natural Resources Use (forest cover, livelihood and equity).

1.6 Scope and Limitations of the Study

The study was conducted between 2006 to 2019 when participatory forest management was operationalised. The period was sufficient enough to examine the influence PFM on livelihood and forests cover. It was limited to the assessment of costs and benefits in PFM and the undelying policies and legislations that influence the utilization of forests resources. The limitation during data collection were on cultural barriers, where some data on the level of education, age and total number of children were not easy to get. The researcher had to be guided by the local CFA leadership. The researcher anticipated to carry out the study during dry period in fear of poor accessibility during rainy season. However, during rainy season, data collection was very tidious, hence this delayed the progress. Some key informanats were adamant in providing information, for fear of lack of authority from their seniors. However, the researcher

had to identify himself with written documents from Government authorities. The researcher also made several call backs on certain situations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Participatory Forest Management (PFM) is a practice that bring together the forests adjacent communities, forests authorities and other stakeholders in a joint management of the forests with an aim of increasing the forest cover and improvement of livelihood. This chapter reviews the various participatory forests management platforms at global, regional and local levels highlighting strengths, challenges and weaknesses of the initiative. The chapter therefore identifies gaps in the ecological and socio economic status of the forest ecosystems and document quantifiable effects of participatory forest management.

2.2 Contribution of Community Forests Association to Livelihood Improvement

Inclusion of community members was designed to increase forests cover by growing crops and tending seedlings to maturity. This practice could ensure high seedlings survival rates at the same time boost crop production, hence improving livelihood of the forests communities (Ongugo *et al.,* 2012). This sub section addresses how participatory forest management reduces poverty and enhances alternative livelihood opportunities among the forest dwelling communities. Some of the economic impacts of PFM (PELIS, bee keeping, firewood collection etc.) have the potential to improve livelihood (Ongugo *et al.*, 2012). Its impacts on CFA livelihood directly influence community involvement in the resource management (Campbell, 2003; Josephine *et al.,* 2024). According to Ghate (2010), community participation in the PFM have direct impact on their livelihood i.e. PELIS, bee keeping, grazing etc. However, despite these anticipated direct economic benefits, information is still lacking to show the level at which it improved the livelihood of the community. Currently many countries are changing policies and legislations to institutionalise PFM. In Kenya, the forest law was enacted in 2005 and subsequently operationalised in the year 2007 with more emphasis on participatory forest

management as a tool. Information was still lacking to account for that reform in terms of poverty reduction and ecological integrity.

The development agencies current interests in PFM have moved from an initial concern in forest conservation to poverty reduction (Ghate, 2010). However, despite the increasing promotion of PFM in the last two decades, there was a growing concern that its impact on poverty reduction remains largely unknown (Catherine, *et al.,* 2017). Scher *et al.,* (2004) noted that it was critical to know the actual benefits on the people's livelihoods around the forests. Both Ghate (2010) and Scher *et al.,* (2004), had not stated the level of livelihood improvement that the communities had obtained from the forest, thus creating a gap that requires a further determination. According to Driciru (2011), Uganda was also facing information gaps that could help in strengthening laws and policies to ensure success of PFM in addressing ecological and socioecomic challenges in the country. Ndwiga, (2010) found out that PFM positively contributed to the livelihood of CFAs in Kerita Forest community in Kiambu, but did not provide the amount of contribution so as to help develop policies on how to bridge the gap. Senganimalunje (2016) also found out that PFM support to livelihood could not be underrated in any economic blue print, but decried scarcity of impirical data to account for its role. This therefore meant the effects of PFM on livelihood of the CFAs required a determination in terms of income levels and the gap needed to be accounted for.

Other studies found out that most rural households within forested ecosystems mainly depended on PFM for rain, food and cash provision, thus forest farming had the potential to address both ecological and livelihood challenges (FAO/IFAD, 2008) and similarly, studies from Africa, Asia and the Caribbean also found out that the rural communities largely depend on PFM for both socioecomic and ecological services (Arild *et al*., 2014). But according to Ongungo (2007), there was a lot of socio-economic data still missing on how forests influence the livelihoods and overall Gross domestic products of the respective countries and great undervaluation of forest services. In comparison both Arild *et al.,* (2014) and Ongugo (2007) were in agreement that forest contributed significantly to livelihoods in most rural settings, but there was no data to support the argument. This therefore leaves a gap that requires a determination.

2.3 Participatory Forests Management as Management Tool in Kenya

This section assesses how PFM can be used to improve the quality of forest ecosystem. Before 2005, the management of state forest in Kenya was solely under the Forest authorities. This subsequently led to rebellion with the forest communities resulting into massive destruction of forest. Involvement of the local people therefore became an option for the co-management of the resource; hence PFM was anchored in the law. Before the operationalization of most of environmental laws in Kenya, concerns had been raised over the need to develop laws and policies that majorly addressed environmental conservation and sustainability through involvement of community in response the Rio Earth Summit (United Nations, 2023) and the World Summit for Sustainable Development (Brundtland, 2002). This came as a backdrop of a continued deterioration of the forest ecosystems in a number of countries around the globe. Finally, a number of Governments and international institutions adopted these measures to address these concerns but unfortunately, minimal achievements were witnessed following implementation of misdirected environmental policies like in India (Tambe *at al*., 2021). Currently, equal sharing of forest proceeds remains unresolved, causing major division between the communities and the host governments. This subsequently saw major institutional and legal reforms to address the concerns in the forestry sector (GoK, 2016).

According to Mishra and Singh (2015) most of conventional forestry approaches, like the PFM had been integrated into environmental laws and policies around the world with little output to account for. With the introduction of participatory forests management in Africa in the 1990s by the Development partners, with the principal objective of devolving its management to the rural leadership (Ribeiro, *et al.*, 2020). The reforms were progressive as found out by Potters *et al*., (2017) and Andersson *et al*., (2014) because it would promote ownership of forests and its resources. However, these legal and institutional arrangements hade not translated into quantifiable tree cover and conflict between the communities and government had continued unabated. A formula for benefit sharing was not considered in these laws and policies. According to Catherine *et al.,* (2017), the impacts of Participatory forests management on critical issues on poverty alleviation and ecological condition still remained largely unaccounted for and this therefore created a gap that requires further investigation.

In Ethiopia, state-controlled forest management became unsuccessful, and new strategies had to be sought to address the disparity (Tefsaye *et al.,* 2024). The existing forest legislations undermined the functional capacity of the traditional forest conservation methods thus led to decline of forest resources both quantitatively and qualitatively (Tefsaye et *al.,* 2024). According to Ongugo (2007), Kenya lost vast area of forests land due to draconian forest law that had been in place since independence. This legislation presided over some of the worst forests destruction in the history of the country because it excluded the forests communities. There was a glaring legal and policy gaps to realign management of forests and its resources in Kenya (Ongugo, 2007). The forests management approach was lopsided, delink of the realities at the time. Another approach to address forest degradation was the introduction of farming types within the forest like introduction of butterfly and agroforestry practices to reduce pressure on forest resource to unsustainable consumption (Nature Kenya, 2020). In further analysis, Ogungo, (2007); Nature Kenya (2020) and Tesfaye *et al*., (2024) were in concurrence that the all-exclusive forests management approach could compromise the socioeconomic and ecologic functional capability of the ecosystem. However, even after incorporating the local community into the management of forests, there was continued forest degradation, which according to Ogungo, (2007) and Nature Kenya (2020) was all about benefit sharing and protection of forest resources respectively. This was an area that required determination, through the community views, on how the forest resources could be consumed equally among the players involved in the management.

2.4 Contribution of Participatory Forests Management to Forest Cover

This section reviews the contribution of the involvement of the community forests association on protection and management of the resource. Before introduction of PFM, forests and its resources were under the sole management by the government. The micromanagement effect led to qualitative and quantitative degradation of forests and its resources, save to the enactment and subsequent operationalisation of the Forest law in 2005(GoK, 2005). Involvement of community members in forests resource management had been piloted in many developing countries, especially in Sub Saharan Africa, as a sustainable forests management approach because of its all-inclusive nature (Turyahabwe, 2012). It had therefore been applied to restore functional ecological capacity of threatened landscapes. PFM initiatives had also been done in a transparent

and accountable bringing all stakeholders on decision-making process (Agbogidi *et al.,* 2010). However, no study has been done to authenticate the size of forest cover since its inception in 2005. The argument here was that PFM as a management tool provided for a regulated and legal access to goods and services within the ecosystem thus enabling essential silvicultural operations to thrive undisturbed (Campbell *et al.,* 2012). However, inadequate CFA participation would compromise tree quality due to unlimited consumption of the resource (Campbell *et al.,* 2012). However, according to Scher *et al*., (2010), there was still some gaps on the contribution of PFM on improvement of forests quality and quantity through application of limited consumption of the resource. It therefore became necessary to determine the quality and conditions of the forest ecosystem in participatory approaches in Lembus forests.

Impact of PFM in Bonga Forest, Ethiopia, resulted into a significant improvement of forest conditions through sampling densities, increased vegetation structure and a healthy population distribution across diameter classes (Tesfaye, *et al.,* 2024). A study carried out in Tanzania found out that the PFM recorded a remarkable high quality trees, a function of participatory approaches in forests management (Kajembe *et al.,* 2005). In other studies done in India, there was an improved quality of trees when the community were involved in the forests resource management (Prasad *et al*., 2023). There was a concurrence i.e. Kajembe et al., (2005); Prasad *et al.,* (2023); and Tesfaye *et al*., (2024) that PFM could potentially increase vegetation cover through species abundance and diversity, however, social economic, ecological and cultural aspects of riparian communities vary from one country to another and this might affect the overall outcome of the PFM in specific areas.Policy and legislations of forest management also vary considerably in various countries and this therefore required a determination on the effects of PFM on forest condition under the local socio economic, ecological and cultural considerations.

Biological diversity was one aspect that was highly degraded before the implementation of PFM initiative, however empirical data on the same had not been documented to assess its influence (Okumu and Muchapondwa, 2017). PFM primarily targeted improved livelihood, alongside mitigating the effects of deforestation. The success of PFM according to Kallert *et al., (*2000*)* was reduction of forest resource overutilization and unlimited public participation. Kellert *et al.,* (2000). Most multilateral partners and donor agencies found it easy to support participatory

approaches after many developing countries had liberalized their economies and reformed the forestry sector through legislations (Salomao and Matose, 2007). One major reform was devolution of functions and resources in the development of the forestry sector to the local community (White and Martin, 2002). The Government main role was therefore to transfer resources to support such activities through sound forest management (Potters *et al.,* 2022). However, currently, there still exists gaps in quality and quantity of forest cover, its influence on community livelihood and conflict resolution on consumption of forests resources.

Other studies done in Ethiopia, i.e. Gautam *et al*., (2004) revealed that the impacts of PFM had shown a decline in rate of deforestation and forest degradation. ButFerraro and Pattanayak (2015) suggested on the need to carry out a continuous environmental impact evaluation to assess the relevance of the legislations to restore the degraded landscapes. For instance, both Gautam *et al.,* (2004) and Ferraro and Pattanayak, (2015) were in concurrence that the local participation had restored the ecological functionality and that there was need for sustained evaluation of the impact. However, the two researchers did not account for the effect of non public participation on degradation of ecological landscape. This therefore, required the forest ecosystems should undergo continuous evaluation in terms of tree cover to assess the effects of the PFM.

2.5 Benefit Sharing in Forest Resources

This section reviews how forests resources were consumed by the two major stakeholders; the Forest authorities and the communities. It is focused on the advantages between the input and output in the Plantation Establishment and Livelihood Establishment Scheme. Benefit sharing within the wider forest management, was defined as an ability to have an equal opportunity to access and consume forest resources and recognized by an international law (Morgera, 2015). The participatory forests management would capacitate the locals to manage and develop functional systems that protect forest resources and also generate royalties from the products (Jephine *et al.,* 2012). The government therefore delegated responsibilities to the grassroot leadership. In the process, the proceeds accruing from the utilization of forest was supposed to be consumed equally between the locals and forest authorities (Thenya *et al.,* 2007). However, the method for benefit sharing amongst the two parties (Forest Authorties and CFAs) was not identified and this provided a gap that required a determination.

A number of Studies i.e. Borrini-Feyerabend, (1997) and Victor (2019) found out that equal consumption of natural resources would translate into better sound management practices that led to high productivity. According to Agrawal and Ribot, (2006), the grassroot leaders with delegated responsibilities had limited authority and access to resources and their input were always looked down upon by the main state actors in areas of conflict resolution. This contradicted the provision of the Forests Act, 2005 on PFM that called for equal participation and management (GoK, 2018). Agrawal and Ribot, (2006) did not provide the reasons why the local communities were not allowed to sell any forest produce, hence emergence of conflict. It therefore called for analysis of Costs and Benefits of PFM tools like the Planatation Establishment and Livelihood Improvement Scheme.

Development partners suggested that line should be drawn on which powers to be devolved and which could be retained by the Forest authority. This would facilitate transparency and accountability at each level of management, thus reducing misuse of resources and integrity (Mbuvi and Kungu, 2021). At every level of devolved functions, there must be some principles of democracy, where community members elected their leaders in the management process. This was done to ensure transparency and accountability in the resource management (Nygren, 2025). But despite the democratic process as shown by both Agawal and Ribot, (2006) and Nygren, (2025), still there was conflict in resource use among the communities and the government. There was therefore a need to find out the major consumer of these resources and develop a strategy on equitable solution in sharing of forest resources.

In Uganda, resource utilization, consumption and sharing were provided for in the forest laws. According to Ugandan Authorities, forest services with low value were left under the management of the local forest level management, while high value ones were the sole responsibility of the high-level management. These included items like water ponds, ecotourism, and timber revenue in another category for low and high level management respectively (Bugabo *et al.,* 2023). In other jurisdictions for example in India, there were multiple issues on resource sharing, between the distributors and the consumers. Not all these studies showed ratio of consumption of forests resources to provide appropriate benefit sharing criteria. This would help in formulation of appropriate legislations to address consumption of the resource.

Studies from the Philippines showed that poverty level had shot up because the vast majority of forest resources controlled by the minority, thus resulting into abuse and mismanagement of the resources among the few minorities at the expense of the vast majority (Gasner *et al.*, 2021). This skewed and imbalanced management of forest resources had resulted into rise of rebellion and in fighting among the population (Pulhin and Inoue, 2022).The centrally controlled forest management approaches did benefit the rich and economically endowed people instead of the poor with full dependence on forest and its resources for survival (Miyakawa *et al*., 2005). Unstable policies and legislations on Community Based Forest Management initiatives like the restrictions of resource use permits, as well as the cancellation of Community Based Forest Management programmes had influenced negatively on the resource consumers (Pulhin and Inoue, 2022) among other challenges. More forests reforms were carried out in the South America, but the fear was that they were focused on the national management, thus excluding the local community from participating. Reforms of such nature had always resulted into conflicts hence informed the grounds to find out the main beneficiary or loser in the entire value chain.

The Indian government allowed the involvement of community members in forest resource management but maintained limited access in an effort to restore degraded ecosystems, fearing unregulated access and consumption. When access to forests resources was restricted, there were signs of disquiet that could lead to protest (Saxena *et al*., 2021). Similar efforts to address inequality in consumption of forests resources was also seen in the neighboring countries of Nepal, and Sri Lanka (Ranjit, 2019). However, no known formuales was found to inform policy and legal reforms and this formed a solid ground in this study with special reference to Kenya.

Community forests participation in Kenya was effected with enactment and operationalization of the Forest Act, 2005 (GoK, 2005). The Forest Act, 2005 came with far reaching reforms, which included formation of Commnuty Forest Association (CFA) membership, penalties for abuse of forests among others (GoK, 2005). The Lembus forest provided a better definition of an ecosystem managed by the principle of preservation and conservation, because it had some historical sites with spiritual and cultural relevance to the community GoK, (2018). In Kenya, it was mandatory that the participating community members had to enter into an agreement with the Forests authorities over the consumption of granted a user rights in the state forests. This provided a limited opportunity to community members to participate because it was largely in

the interest of the forests authorities (Agrawal and Ribot, 2006). Such provisions, according (Agrawal and Gupta, 2005), undermined the spirit of community forests participation, because members still had limited powers within the definition of joint forests management. Forests farming (PELIS) which formed key component of PFM to support community livelihood was also introduced as part of change of forest legislation in 2005, however, the system was further faced with issues of equity among CFA members (Thenya *et al*., 2007**).** There was a need to strike a balance on how the scheme (PELIS) could serve the interest of the local membership while embracing sustainable forest management principles as spearheaded by the Government. These weak links needed further investigation in order to facilitate the balance.

In 1975 participation of local community in the management of forests were limited to only private lands. Continued degradation of forests prompted the Government to initiate a Forestry Master Plan to operationalise reforms by allowing community participation in the public forests (Kairu*et al.,* 2024). This later led to the enactment of Forests Act in 2005, which comprehensively provided for the community participation in the State forests. By allowing stakeholder participation in the management of the country's natural resources like forests, the Government devolved functions to grass root level as had been practiced in other jurisdictions (Khanal, 2024).

Participatory approaches was therefore an all-inclusive and consultative forests management tool. It upheld the principle of equal access and utilization to forest resources among all stakeholders involved in the joint management (Kallert *et al.,* 2000). There were inadequacies in the forests resource consumption criterion as was witnessed in India, Uganda and other parts of the world. According toDriciru, (2011), there were gaps in measuring forest services meant to the community and this needed to be determined to qualify PFM contribution to livelihood. There was an evident of imbalance in distribution of the resources between the local community and the forest authorities. There should be some amendments to the current Forests Act, 2005 to put in place equitable provisions in benefit sharing of the forest products. Other studies had shown distribution of benefits from Key User rights like PELIS in Kenya. Proceeds arising from PELIS had been in favour of the forests authorities in areas of plantation establishment as compared to the costs the farmers incur (Thenya *et al*., 2007). The result found out that there were limited benefits from PELIS as compared to costs involved. In the final analysis, he

strongly recommended that the benefit from PFM should supersede the costs involved (Ndwiga, 2010).

Even with the operationalisation of PFMPs in various CFAs in the country, the community members still had limited access and utilization of the forests and its resources. Distribution of benefits became a challenge in countries like India where the formulae was believed to be imbalance. This led to some disquiet among forest consumers. (Saxena, 2021). Challenges related to forests resource consumption in transparent and equitable manner was also witnessed in the neighboring countries like Nepal (Ranjit, 2019). This pointed a glaring gap on misfortunes of forest resource consumption that require a determination.

2.6 MajorForests Ecosystems in Kenya

Unlike Lembus forests in Baringo County, other forests in Kenya did share similar socio economic and ecological challenges that required a national policy intervention to address. This section therefore analyses socio economic and ecological implications of major forests ecosystems in the country and their relationship with the study area. The Arabuko Sokoke forests along the Kenya Coast experience two rainy seasons starting in April and ends in June, while the short one commences as from November and stops in December (Matiku *et al.,* 2013). This was closely similar to the rainy patterns in the Lembus forest ecosystem**.** With annual rainfall ranging from 1,000 mm in the east to 600 mm in the northwest, the remaining months were often hot and dry. Socio economically and historically, the colonial government had denied the indigenous communities access to forest resources. During the period, the population of the local communities was low, hence little demand for forest resources (Barrow *et al*., 2002). As the population shot up the colonial government imposed permit based access system thus significantly degrading local people's customary rights. This therefore necessitated the need for participatory approaches (Barrow *et al*., 2002).

Another study to investigate the effects of collaborative forest management on communities close to the Arabuko Sokoke forest was also done (Matiku, *et al.,* 2013). In a parallel study within the same ecosystem, Musingo, (2013) further evaluated the community's reported implications of collaborative forest management on communal livelihoods. The socio-economic position of forest communities is a significant outcome of participative forest management in

Kenya. In 1997, the Arabuko Sokoke forest first tested collaborative forest management (Matiku, *et al.,* 2013).The two studies, Matiku *et al.,* (2013) and Musingo, (2013) were in concurrence for an investigation of a livelihood gap associated with community inclusion PFM in Arabuko Sokoke forests whose ecological and socio-economic conditions are similar to Lembus forest ecosystem. This is a clear indication of an existing gap. According to Ongugo, (2007), Kenya implemented collaborative forest management primarily in response to demands from local people living adjacent to forests and civil society organizations seeking to mitigate deforestation. This consequently offered a national perspective on the forests in Kenya, indicating that they share socio-economic challenges related to participatory forest management.

Like Arabuko Sokoke forest, the Taita Hills, were also in the Kenya Coast. It is located at 03° 25’ S and 38° 20’ from 700 to 2208 meters above sea level (Nina, *et al*., 2009). This is almost ecologically similar to Lembus forests, which stands at 2391 meters above the sea level with an average annual rainfall of 1200–1800 mm. There were many rare and endangered plants and animals that live in the Taita Forest environment, but those who lived in the Taita Hills were not all comparable (Agrawal and Gupta, 2005). The Lembus forest too is heterogeneous in ethnic composition though the majority of inhabitants are Tugens with a significant number of Kikuyu and Luo ethinic communities around Maji Mazuri forest block. Attributes of inhabitants residing in the Taita Hills, as determined by Agrawal and Gupta (2005), encompased socio economic status and the ability to influence decision-making processes in forest management. *N*ina *et al*., (2009) carried out a study that looked at local perspectives on the of community involvement in forest management in Taita Hills during the development of forest policy, thereby confirming Ongugo's (2007) claim that the implementation of collaborative forest management aimed to challenge the oppressive colonial laws for all communities near Kenyan forests.This indicated that most forest adjacent villages in Kenya have similar challenges in the enforcement of the existing forest legislation.

The Aberdare Ranges, which stretch 120 kilometers southward to Nairobi and span around 40 kilometers at its broadest point, shared ecological traits with the Lembus Forest. Lembus forest sits at 2,391 meters above sea level almost similar to the Aberdare, which was even higher. Both were characterized as high forested and ecologically sensitive zones (Hansen, 2013). The forest is predominantly characterized by the pioneer species *Macaranga capensis* and *Newbutonia*

macrocalyx, which extended to the eastern half of the range. Donald and Teiji (2016) primarily validated the presence of valuable economic species like *Aningeria adolfi-friederici, Ocotea usambarensis,* and *Syzygium guineense* in the Lembus forest ecosystem. Wambugu *et al.,* (2018) conducted a study within the same ecosystem to assess the impact of forest ecosystems on the household economy of the neighboring community and their participation in collaborative forest management inside the ecosystem. There were major socio economic and ecological concerns of most major forests in Kenya in which Lembus forest can be used a sample representation.

Distinguished from other forest ecosystems in Kenya, Kakamega forest is the easternmost remnant of the Guinea-Congolian tropical woods, extending across the Zaire basin from along the Atlantic Coast (Mitchell, 2004). The geographic positions are 0° 2' N, 34° 47' E, and 43° 58' E. The ecosystem is a rainforest characterised by a distinctive assemblage of both flora and fauna species that is renowned for its abundant avian and insect diversity. The woodland receives an annual precipitation of approximately 2.08 meters (Bleher, 2006). The temperature is very stable year-round, with average daily minimums around 12°C and average daily maximums approximately 26°C. Kakamega Forest is one of the sixty significant bird sites in Kenya and a crucial biodiversity region (Musila, 2006). The 1994 welfare monitoring survey indicated that 52% of the county's population resided below the poverty line, signifying their inability to adequately afford essential needs such as food, shelter, clothes and education. Consequently, there was a significant dependence on the forest to fulfill their everyday needs.Although there was temperature and rainfall variation according to Bleher, (2006), the range was not significant (Donald and Teiji, 2016***).*** This essentially meant both ecosystems were characteristically similar both ecologically and socio economically, thus making Lembus ecosystem nationally representative. According to Welfare monitoring, there was a further concurrence that both Kakamega and Lembus communities (Donald and Teiji, 2016) largely depended on forest for basic commodities.

Perched atop a volcanic peak, the Mount Elgon forest ecosystem also share elevation status similar to Lembus i.e. 4,320 m. This rendered the mountain one of the tallest in the East African region. Although Lembus forest was not known for any volcanic activity, Mount Elgon has many volcanic formations (Vedeld *et al.,* 2005). However, the two neighboring forest communities largely depend on forest resources for needs (Nield *et al.,* 1999). Ecologically, Mt. Elgon is 4320

meters above the sea level (Scott, 1994) while Lembus stands at 2391 meters above the sea level (Teiji, (2016). Both share similar agro ecological characteristics. The resources of Mt. Elgon could be classified into three categories. The woodland region gives traditional socio-cultural, ecological, economic, and livelihood values to religious and cultural events, including circumcision rites and spiritual gatherings. The predominant resources currently taken from forests include all forests user rights provided for by the law including firewood, bushmeat among others (GoK, 2005).

The Marsabit woodland exemplifies the Northern Kenya ecology. This distinctive dry woodland holds significant ecological and socio-economic value for the inhabitants (Githae *et al.,* 2008). It is situated at 01˚ 15' North and 04˚ 27' North latitude and 36˚ 03' East and 36˚ 59' East longitude.The ecosystem was managed primarily for forests and wildlife conservation. The ecosystem extends over 157 square kilometers, with an altitude of almost 2000 meters. The area is largely marginal with low precipitation. The soil type is highly well drained with capacity to support agricultural production. Southeasterly winds caused the prolonged precipitation period (March-May). Precipitation predominantly occured during the long and short rainy seasons. The intermediate intervals were arid. February often sees peak temperatures, fluctuating between 30 and 35 degrees Celsius, while March and July record the lowest temperatures, ranging from 22 to 25 degrees Celsius. There was slight variation in terms of climate as compared to Lembus, though many similarities exist in socio economic and other ecosystem services. The inhabitants of Marsabit benefit from numerous ecosystem services, including water, firewood and grazing land. Similarly, Lembus community (Teiji, 2016) also consumed these same services. On tree species dominance, Githae *et al.,* (2008) confirmed Teiji, (2016) findings that Podocarpus *gracilior, Spathodea nilotica* and Juniperus species were all endemic in both forest ecosystems, thus making Lembus forest ecosystem a national representative in the study.

Another vital ecosystem with several social and ecological similarities to the Lembus forest ecosystem is the Mount Kenya forest. It occupies an ecological zone within the broader Mau complex, which encompasses the Lembus forest. The Central Highlands Conservancy houses Mt. Kenya west while the Eastern Conservancy houses Mt. Kenya East. It is characterized by its craggy, glacier-covered peaks and diversified forests. Although the Mt. Kenya forest habitat contains numerous volcanic formations, comparable features are absent in the Mau. The average

temperature declines by 0.6°C for every 100 meters of elevation gain. The upper elevations of Mt. Kenya are characterized by an afro-alpine. The Ecosystem recorded maximum rainfall between 2,700 and 3,100 meters, a situation similar to that of Lembus Forest. In terms of rainfall distribution, Mt. Kenya ecosystem is nearly closer to the Lembus forest. While the latter records between 900mm to 2300 mm annually, the former has 1200 mm and 1800 mm. This qualifies the two zones into similar agro ecological zone (Teiji, 2016).

Similarly, the Mt. Kenya ecosystem influences greatly climate pattern because it occupies a larger catchment area. Mount Kenya is catchment of most of Kenya rivers, including the Tana River. It accounted for about 53% of the total drainage capacity. The mountains provided water to approximately 52% of Kenyans, contributing to about 74% of the country's hydroelectric electricity. Communities residing around Mount Kenya Forest Reserve primarily engaged in agriculture for subsistence and other socio economic needs. The ecosystem possessed significant agricultural potential because of its excellent soils and consistent rainfall. Therefore, the villages adjacent to the forest habitat depended heavily on agriculture as their primary economic sector. Local communities next to the ecosystem depended significantly on products from forests. Households neighbouring the forests depended more on forest goods than those residing at greater distances. Impoverished households use the forest more than affluent ones, while farms with little tree coverage exploit it more than those with abundant trees. Utilizations of forests encompassed firewood, medicinal values and apiculture.

2.7 Policy and Legislations on Participatory Forest Management in Kenya

In Kenya, there exists a number of laws that influence forest cover, livelihood and equity improvement. Whereas the principal legal tool used in Kenya for forest conservation and management is the Forest Act, 2005, there are other legal instruments with supportive provisions on tree growing and benefit sharing. These include the Environment Management and Coordination Act (EMCA, 1999), the Agriculture (Farm Forestry Rules, 1999 and the Constutition of Kenya, 2010. Others are the Kenya Vision, 2030, the Medium – Term III (2018 – 2022) and the Wild life Policy of 2011 among other International conventions and obligations. Likewise, these same pieces of legislations like the Forest Act, 2005, the Environment Management and Coordination Act (EMCA, 1999) and the Agriculture (Farm Forestry Rules, 1999) have some provisions that support livelihood and Equity. The primary objective behind

undertaking tree growing in both public and private lands in Kenya has a secondary livelihood component. The primary goal of community inclusion in forests management was to ensure increased tree cover and livelihood enhancement. This section evaluates the policy and legislative gaps associated with forest, livelihood, fores and equity.

2.7.1 Legislations Influencing Forest Cover in Kenya

2.7.1.1 The Forests Act, 2005

The Forests Act 2005 underscores the need for community involvement in forest resource management and promotes their active engagement. The law further provides for formation of Community Forests Association (CFAs). The CFAs has to register with the registrar of societies and comply with all requirements before registration. To operationalise the registration status, the CFAs had to develop a participatory forests management plan (PFMPs). PFMP is a tool used in management of forests outlining the rights to consumption of forests resources, roles and responsibilities and equitable consumption of forests resources (GoK, 2005).

However, majority of forest-dwelling communities lacked fundamental awareness of their rights regarding forest management (Ongugo, 2007). These rights further required operationalisation through policy statements in an effort to build the capacity of the locals. Forest Act, 2005 provides for community capacity building on user rights, but this provision had not been operationalised into a regulation or guidelines. The Kenya Environment Policy of 2012 established a right to development. The policy mandated the use of the right to development to address economic, social, and environmental needs. This needed to be broken down further, so that the farmers were made aware of terms and conditions of engagement with the forest authorities. But Ongugo *et al*., (2007) asserted that civil society organizations had willingly assumed the responsibility of enlightening the public on the merits and demits of such policies during public participation. The new management approach requiredthe support of all those who were anticipated to implement or be impacted by it in any capacity**.** However, there were no legal provision either as a policy statement or in the Forest Act, 2005 that provided for this. A legal gap therefore existed in the community capacity building on how their rights could be enhanced on the joint management of forests.

In an effort to revert forests ecological degradation, law provided for the provision of incentives and benefit sharing (The Forests Act, Part VI, and Section 53). This implied to all investors in the forest sector to share the benefits accruing from that investments with the local community in areas like infrastructure and social amenities like schools, hospitals and churches. This strategy had not worked since the introduction of participatory forest management into the Act. The Forest Act, 2005 did not provide for the formulae for benefit sharing and options to follow in an event that agreement was not obeyed. More importantly, the law did not include the government as a major player in the forestry sector on benefit sharing scheme. According to Driciru (2011), such a formula was yet to work in many countries, including Uganda, thus frustrating efforts to increase the tree cover in the county. There could therefore be a policy or a legislation providing for a redress in an event an investor failed to comply with the existing law. Kenya, for example had a number of multinational players in the forestry sector like the Comply LTD, RAI PLY. Others were the tea-based industries in Kenyan highlands especially in Kericho, Nandi and Kiambu counties**.** Nothing could show any significant increase in the tree cover since the law was operationalised.

In order to spur rapid forest growth within the local landscape, the forests law gave powers to the high-ranking State officer in charge of Monetary and fiscal matters to come up with taxes and other incentives to ensure rapid investments in the forests sector (GoK, 2005). This happened upon receiving a technical advice from the Forestry Ministry, hence promoting forest conservation and management on forest cover. The provision within the Forest Act, 2005 has never been operationalised and therefore required a policy on public participation on Forests investments among the local entrepreneurs who were the key stakeholders in the industry. National Tree Planting Week and International Forest Days were also provided for in the Forest Act, 2005 (Part VI section 53). Major stakeholders in these events are only limited number of Government departments, unlike in other countries, which such events are made National holidays to involve all citizens to participate, like Rwanda. There was therefore a need for a policy intervention to involve all Government departments and citizenry for a compulsory participation.

Forest Act, 2005 also provided for Concession. A concession involved the partial or complete conservation designation of a forest area through the creation of a forest management plan that

included inventories, reforestation, and replanting initiatives. Additional components encompassed annual work plans and community user rights and rewards. This was a strategy aimed at ensuring increased forest cover through a specialized management entity other than the Government (KIPRA, 2023). However, to initiate the process, there needed to be a policy back up for a mandatory development of a regulation to operationalise the provision. In socio economic development within the forest catchment areas, the Forests Act, (2005) did provide for public involvement in the management of the forest. This was done by forming a Community Forest Association, which in turn formeda binding memoranda with the Government on management modalities and strategies. In return, the CFA members were given user rights to access goods and services from forest like grazing, fuel wood collection, honey harvesting among others (Part V Section 48 (1). The legal provision in the Forest Act, 2005 did not not provide on how the royalties of the forest produce would be mutually consumed among the primary stakeholders, which was key resources in terms of infrastructural and social amenities development. The County governments had consistently demanded for the devolution of forest management, with an aim of improved conservation strategies aimed at increasing royalties (Ongugo, 2007). The land on which the forest sat traditionally was an ancestral land and the community had all the rights to benefit from all forest proceeds (GoK, 2021). Part VI, Section 53 of the Act, emphasised on benefit sharing with reference to investors in the sector, but failed to provide the same with the forest authorities. This therefore left a policy or legislative gap on how the real benefits like the royalties could be shared between the Government and the community.

The Forest Act, 2005, Part V Section 48 (1) refered to investors to share the benefits accruing from such investments with the local community in areas like infrastructure and other social amenities like schools, hospitals and churches, but did not provide the criteria or guidelines on benefit sharing. Part IX took away people's access to forest areas for serious offences, especially at dusk and dawn, with designated roads or footpaths. This was done to promote goods and services as described in Part V Section 48 (1) of the Act. However, it did not take into account the fact that people could be collecting honey or tilling for plantations through non-resident cultivation during these times. This therefore left a legislative gap, considering an agreement had been entered between the CFA and the Forest authorities. Operationalisation of the Act into Regulations could only take effect after the Cabinet secretary found it necessary and found it fit

according to prevailing circumstances. This affected the critical socio-economic services from the forests including the incentives and benefit sharing (PART X, Miscellaneous). Regulations essentially could be in place immediately the Act was operationalised, especially on provisions that concerned community livelihoods.

FCMA (2016) did not expressly provide for benefit sharing between the Government and communities, however, it did provide on the same between the communities and investors (Part V Section 48). This was a deliberate effort by the Authorities to avoid equitable consumption of ecological proceeds while the Natural Resource (Benefit Sharing Bill, 2019) categorized forest, biodiversity and genetic resources as some of resources that had to be shared with the community. This grey area required legislative or policy intervention. In order to address forests ecological degradation, the Forest Act, (2005) further provided for a special fund called Forest Management and Conservation Fund. The fund was meant to support exemplary efforts that support forestry development. The implication of provision was to identify talents with innovative approaches that could complement already existing technologies. The fund was available to all stakeholder in the sector, including the CFAs towards tree planting. However, limited number of CFAs are aware of such provision in the Forest Act, 2005 (GoK, 2021). Transparency on existence of such initiatives is the responsibility of the institutions created by the law to oversee such operations.

The Forest Act, 2005 further provided for the management of the community forests. These forests were under the management of the forest adjacent communities (CFAs). It was also a legal requirement that entities involved joint management of forests with the Government had to register in compliance the law. The forests authorities in consultation with local legal institutions would operationalise the activities of the community in line with the best forestry management practices and provide incentives like loans in case of resource gaps in the management. The implication of this provision was to allow as much a possible all stakeholders involved in forest development to seize the opportunities available to plant trees**.** However, little information was known about its existence (GoK, 2016).

The Forest Act, (2005), Section 40 Subsection (1) provided for the concession by the KFS, upon certification by the Environmental Regulators of the country with an aim to protect biodiversity,

cultural and recreational areas and to avoid reoccurrence of forest fires. This was a deliberate step to put the forests management in compliance to its guidelines and management plans for high productivity. The provision was a strategic intervention on increased forest cover**,** however, the local CFAs might not have the capacity to implement it due to financial strength required.

The Forest Act, (2005) further provided for Community capacity building on how rights could be enhanced on joint forests management. This was a function of the forest's authorities. The CFAs wpild be knowledgeable on tree nursery establishments, entrepreneurial skills and other livelihood-based project management. However, only limited number of people wereaware of such silvicultural operations and this would compromise their ability to protect the trees.

2.7.1.2 Environment Management and Coordination Act (EMCA, 1999)

Environmental Management and Coordination Act, 1999 provided for the protection of forests of existing forests in the country. It laid more emphasis on carrying out some environmental impact assessments for all forest-related activities like logging, afforestation, excision among others. According to the Act, the Environment authority was supposed to work with lead agencies to develop and issues guidelines, which prescribed an attainment of the UN threshold of 10% tree cover. Section 9(2) (r) of the Act requiresdNEMA to develop guidelines for achievement of a 10% tree cover. This was a joint initiative between NEMA and other key lead institutions and NEMAhad to develop Regulations and Guidelines for the management of Hiltops, Hillsides and Wetlands. The management strategies to included reforestation and afforestation. Further NEMA was mandated to commence the Commemoration of World Environment Days (WED, Wetlands Day, Desertification Day, Cleanup Day). The Act provided for the restoration of highly degraded and fragile ecosystems through afforestation and reforestation. These included hilly and mountainous areas which were vulnerable to soil erosion, landslides, illegal logging and any other unforeseen environmental disasters. Depite all such provisions, no regulations had been made to operationalise areas like hillside and hilltop afforestation to facilitate tree growing.

2.7.1.3 Agriculture (Farm Forestry) Rules, 2009

The legislation was meant to promote and maintain farm forestry to at least 10% of the farm holdings in compliance to other legislations that advocated for environmental sustainability. This provision called for an all-inclusive involvement in tree planting, especially in farm forestry. The

rule had gained momentum since Agricultural functions had been devolved to the County Governments. It provided for integration of tree, crops within a farm, and ensured security in food production and ecological integrity. However, its contribution to tree cover improvement had not been known. However, the public knowledge about it remained unknown.

2.7.1.4 The Constitution of Kenya, 2010

The Constitution of Kenya, 2010provided that the state and other organs to ensure the country operates within a 10% tree cover threshold. This was the internationally required standards that met hydrologic and environmental sustainability of the existing ecosystems. The Constitution, being the Supreme law required that every citizen (CFAs, government agencies and all stakeholders) to participate in tree planting exercise throughout to attain the anticipated 10% tree cover. However, its contribution to tree cover improvement had not been established and further the level of community awarenss on its provision was yet to known.

2.7.1.5 The Kenya Vision 2030

Environment formed one of the key pillars of the Vision 2030. It emphasized the need to attainment of a 10% tree cover threshold as recommended internationally. Vision 2030 also aligned its mandate to the forests sector with an advocation on sustainable utilization and management of its resources for the present and future economic growth. It had the potential to considerably increase tree cover if public participation was effectively done. It provided for *a 10% forest cover by 2030 and sustainable utilization and management of its resources for the present and future economic growth.* However, the level of public participation and engagement on the Vision wasunknown among the public.

2.7.1.6 The Medium-Term Plan III (2018-2022)

The policy advocated for ecosystem and landscape restoration through indigenous forest conservation with emphasis on sustainability in water and ecological integrity. This related to all relevant Government agencies involved in environmental conservation to spearhead and integrate in the strategic and work plans for the purposes of implementation. The document was a sure way of effecting tree cover in the country, however the public knowledge about it remained unknown and this required a determinition.

2.7.1.7 The Forests and the Big 4 Agenda

The Government undertook the Big Four Agenda as a flagship project. This made it mandatory for all Government institution to integrate tree planting activities alongside all the thematic areas of Housing, Health and Manufacturing. Under housing, the furniture industry was identified to strongly depend on inputs from forests. In health, forests were identified to play critical as carbon sink capabilities. It provided for the protection of forests and its resources for sustained provision of ecosystem services to spur economic growth (GoK, 2022). However, it remained unkown the level of public participation and engagement on it.

2.7.1.8 The Wildlife Policy, 2011

The Wildlife Policy, 2011, stated that animals find settlement under trees. Animals too feed on some trees and it was the responsibility of the authorities, communities to protect existing vegetation and tree for the benefit of the wildlife.This implied that the government authorities in charge of Wildlife management, the local communities or any other stateholder had the responsibility to plant trees in an effort to address the policy statement.Apart from the Government agencies in the sector, the public clearly was unware of its potential to increase forest cover and this required a determination (GoK, 2021).

2.7.1.9 Sessional Paper No. 3 of 2009 on National Land Policy

The policy primarily targeted the restoration of degraded ecosystems by introducing incentives that support such initiatives. It laid emphasis on protection of fragile ecosystem and development of the riparian communities. Upon operationalisation of the policy, it ought to address zoning of catchment areas in order to reduce degradation of the fragile ecosystems. However, public knowledge about the Paper was not known as it formed a critical platform to address deforestation challenges in the county. However, its potential to improve forest cover was largely unkown among the public (GoK, 2016).

2.7.1.10 The Sessional Paper No. 1 of 2017 on National Land Use Policy

The policy addressed how land resources could be consumed fairly and sustainably for present and future generations. It further provided procedures and guidelines that addressed constraints in land utilization and related resources. Once the policy had been operationalised, it could address among other protection of water and its resources, mitigation of weather variability to

ensure rainfall reliability. It also provided a framework for tree planting to mitigate long-term climate change. However, its contribution to tree cover improvement was not known especially among the public.

2.7.1.11 Influence of Other Policies on Tree Cover Improvement in Kenya

A number of policies play critical role in enhancement of tree cover in Kenya, these include the National Policy for Disaster Management, the National Water Policy of Kenya, 1999 and The Kenya National Climate Change Response Strategy, 2010. Others are the National Biodiversity Strategy of 2000 and the International conventions and obligations. These instruments are could spur rural afforestation programmes if adopted and practiced. National Policy for Disaster Management for example laid more emphasis on need to be alert from the Government, communities and other players who hold the stake on Disaster Risk Reduction. One principal concern was to reduce the effects of disasters, especially in prone areas like landslides etc. by massive tree planting as risk reduction strategy. The policy provided the need for all stakeholders to be prepared for a disaster anticipation, preferably by planting tree in disaster prone areas. This a tool that could potentially turn around most marginal areas prone to landslide to be green. However, the level of public knowledge remains unknown.

The National Water Policy of Kenya, 1999 oulinedpolicies that targeted management of water sector for posterity by providing guidelines on how the set objectives would be met. The policy laid more emphesies on achievement of sustainable development and management of the water sector by providing mitigation measures that reduced degradation of water resources like tree planting in catchments. However, the public awareness on its importance and implications on greening the environment remained unknown. The Kenya National Climate Change Response Strategy, 2010 was also formed to provide a framework for climatic variability with reduction strategies, which included among others massive tree planting to address climate change challenges.

The strategy provided for the causes and mitigations of climate change in the country, but its adoption and implementation remained largely unkown among the public. Another key legal instrument was The National Biodiversity Strategy of 2000, which formed to address sustainability of Biodiversity management, by operating on a national platform that addressed

present and future generations. Tree planting had been identified as intervention to offer wildlife habitat in all the ecosystems across the county. Trees provided habitat for wildlife and therefore this strategy was a measure to increase tree cover in wildlife ecosystems in the country, however, it remained unknown on the level of public awareness to spearhead greening the environment. The same applied to International conventions and obligations which mandated the Government to demonstrate compliance to International Treaties and Agreements with more emphasis to ecosystem restoration. This mainly involved massive tree planting with a targeted projection of about 5.1 million Ha by the year 2030. This was a milestone contribution towards the African Forests Initiative and other international conventions in which Kenya is a signatory. It provided for the Government's commitment to effect compliance to global and Multilateral Environmental Agreements demands with large investments in rehabilitation of degraded ecosystems with massive tree planting as a strategy, the level of stakeholder and public awareness remainedunknown to facilitate tree planting programme at grassroot level.

2.7.2 Legislations Influencing Livelihood within Forested Ecosystems in Kenya

2.7.2.1 The Forest Act, 2005

Under the Forest Act, 2005, there were several provisions that support livelihood and food security. Support to livelihood was majorly through the adoption of Plantation Establishment and Livelihood Scheme. The law also provided for Community capacity building on how rights could be enhanced under participatory approaches. In section 47(2) of the Forest Act, 2005 gave opportunity to CFAs to carryout activities including firewood collection, medicine extraction and beekeeping among others primarily to address their livelihood. However, livelihood status had never been investigated in the Lembus ecosystem to assess the influence of these legal provisions. Forest Act, 2005, Part VI, Section 53 advocated for the benefit sharing between the public and investors in the forest sector (infrastructure). *Section* 6(3) (a) (iii) of Forest Conservation and Management Act (Amendment), 2016, highlights the need to develop programmes for achievement and maintenance of tree cover of at least 10%of the land area of Kenya. The level of public participation and awareness on these provisions remained unclear because the poverty levels continue to grow.

2.7.2.2 The Natural Resource (Benefit sharing) Bill, 2018

The Bill has a direct influence on community livelihood on consumption of forests resources. It provided for the creation of a benefit sharing entity based at the County level to oversee resource rationalization and consumption and further classified forests as one of the Natural resources. The Bill did not only provide for equity but also improved livelihood standards of the local communities. Currently, there are a number of Natural resources in the country that require a balanced consumption between the Authorities and the local people. These include oil in Turkana, Wildlife resources, Mineral resources among others. It provided that *every affected organization shall work closely with relevant County to develop a mutual agreement on benefit sharing*. Section 27(2) further provided for a county-based committee that runs the benefit sharing issues. These were provisions that support livelihood that could spur rapid economic growth within a number of forests communities. However, what remained unclear was the level of public participation and awareness.

2.7.2.3 Environmental Management and Coordination Act (EMCA, 1999)

The Environmental Management and Coordination Act (EMCA, 1999) provided for protection of forests and environmental impact assessments of forest-related developments. It also provided for issuance of environmental licenses for all forest-related developments. Further, development of guidelines and prescription of measures targeting a 10% recommended functional forest ecosystem in Kenya and Protection of hilltops, hillsides and wetlands. Protection of such critical sensitive areas safeguarded the environment for productivity.

2.7.2.4 Other Legislations that Support Livelihood in Kenya

The Agriculture (Farm Forestry) Rules 2009 providedfor the promotion and maintainance of farm forestry to at least 10% of the farm holdings in compliance to other legislations that advocate for environmental sustainability. The legislation addressed agroforestry as having a direct impact on food security within forested ecosystems. It provided for the integration of tree, crops within a farm, and ensured security in food production and ecological integrity. However, little was known about its potential to address livelihood challenges. This therefore required a determnition of the public awareness on the same. Another primary law was the Constituition of Kenya, 2010. It anticipated a 10% minimum tree cover in the country. Ecologically this balance would ensure sustained rainfall supply that would support food growing systems in the country.

The 10% threshold was sufficient enough to influence rainfall cycle and its reliability for sustainable food production. However, the Constitution making process had always been political with limited participation.

The Kenya Vision 2030 also focused on environmental conservation with more emphasis on natural resource management. Though it also addressed the minimum 10% threshold, it specifiedthe period for the achievement of the same by 2030, thus distinguished it if from others. The International Conventions and Obligations targeted to rehabilitate about 5.1 million ha of dilapidated terrestrial landscape globally. This translated into a Restoration of degraded sites as a major milestone to rejuvenate agricultural productivity in given areas. However, its measurable contribution to socio economic challenges was unknown among the forest communities, hence there was a need to assess the level of awareness. Finally, Sessional Paper No. 10, 2014 on the National Environment Policy, which was formed primarily to address environmental challenges. It targeted the use of natural resources for generations to come to address livelihood security. It laid more emphersies Natural resources management for the current and generations to come for livelihood and socio economic security among the Kenya population. However, like other legislations, its contribution to livelihood improvement remained unknown among the local population. Unlike the Sessional Paper No. 10, 2014 on the National Environment Policy, Sessional Paper No. 3, of 2009 on National Land Policy laid more emphasis on reclamation of degraded ecosystems for productivity, by application of technological and scientific methods of soil conservation to address food security and environmental challenges. It further stressed the need to protect the catchment areas and creation of joint management approach for sustainability of land resources for livelihood and socio economic challenges.

2.7.3 Legislations Influencing Equity in Plantation Establishment and Livelihood Scheme

Though, consumption of forests resources had been imbalanced in several scenarios, several attempts had been done for legislative interventions. Some of the laws that influence distribution of forests resources are as follows:

2.7.3.1 The Forests Act, 2005

The provision of incentives and benefit sharing (The Forests Act, Part VI, section 53) outlined that all investors in the forest sector to share the benefits accruing from that investments with the

local community in areas like infrastructure and social amenities like schools, hospitals and churches. However, this aspect did not provide sharing of benefits with the Government, who is the main player in the sector.

It reads in *part Subject to Article 66 of the Constitution, both local and international entities involved in the forests resource business will uphold equitable consumption of forests resources with the local community, which host the resource. Areas of major interest for joint consumption include road construction, educational and health facilities, employment and other social engagements.*

2.7.3.2 Natural Resource (Benefit) sharing) Bill, 2018

The Bill classified forests as one of the Natural resources and further created a ResourceRationalization team that manage options for equal share of the resource rationalization and consumption. The government (KFS) which was a major shareholder in the forests sector did not provide for engagement with the communities on how to share forests resources especially royalties from forest proceds.

Part V1 Section 9(1) *...all aggrieved persons or stakeholders to sign a joint memorandum before actual operations commences*. Part V1 Section 9(2) *the memoranda is supposed to include benefits that are not financial in nature.* InPart V1 Section 10(1) there is an Established Committee that oversees resource rationalization and consumption based on guiding principles. Some of critical provisions include, Part V1 Section 9(1). *Development of Memoranda on the equitable consumption of Natural Reso*urces, Part V1 Section 9(2) *Sharing of Natural Resources should include projects that do not generate financial returns and* Part V1 Section 10(1) The *Bill establishes a Committee at County level that oversees resource rationalization and equitable consumption.* Others arePart 1 Section 3 classifies forests *as a natural resource with integrity as a major guiding principles.*

2.8 Change Detection in Forest Cover

Changes in forests structure and composition was very vital to compare the state of forest between 2005 to 2019, using a satellite imagery. These changes could be attributed to anthropogenic activities like forests fires, pathological and entomological effects among others. Quantity and quality of forests ecosystem could therefore be observed by aerial survey and

mapping. PFM could therefore be used to ascertain the levels of forests destruction between 2007 – 2019. According to Soraya, (2013), electromagnetic radiation from the sun receives features of forests and interpret its density, composition and canopy cover. The whole process is facilitated by reflection, radiation and absorption. During the process, both changes in terms of time and space in forests ecosystem could be a function of PFM (Soraya, 2013).

Satellite images had always been used to fast access ecologically degraded areas, especially in forests ecosystems. With the introduction of the current Forests Act, 2005, the forests ecological status had significantly improved because of community involvement and monitoring. The application of satellite imagery, made it possible to assess various areas of the forests that had been degraded due to illegal logging, forest fires or disease infected blocks or compartments. The effect of community participation in plantation establishment was equally made simple. Most applicable tool in remote sensing was linear spectral mixing analysis and was done both visually and digitally and application of radar images and multitemporal analysis, hence making analysis easier on the forests status (Asner *et al*., 2009; Thapa*et al.*, 2013).

2.9 Theoretical Framework – Tragedy of the Commons

The survey had been premised on the theory of tragedy of the commons, (Hardin, 1968). The PFM was introduced into the Forests Act, 2005 principally to address the tragedy of Commons. In CAP, 385, the government was the sole player in in the management of forests. These eventually deprived local community their rights to consume forests resources which they had hosted and held in trust for the community for years on end. With Government as the main manager of the resource, the law provided punitive provisions that hindered the local community to access the forest resources. This subsequently made the forest a target for exploitation through illegal means contrary to the provisions of the law. To counter this tragedy, the new Forest law was enacted providing full participation of the local community.

Yu, J. *et al.*, (2012), had also applied this theory in a study conducted on the Great lakes when examining how the lake ecosystem and the infrastructure affected one another. The variables at play were the freight transportation and the changing lake levels. There was a manifestation of tragedy of commons. The Great Lakes ecosystem remained constant to changing levels of climate change. This resulted into natural ecosystem disturbance that also affected international

trade that used the resource. While the lake levels were vulnerable to agents of climate change, the existing infrastructure that depended on it remained constant thus suffocating the ecological functions of the lake.

According to Hardin, (2009), a study conducted in Ethiopia used the theory to explain why the forest in a country could barely have fuel wood for domestic consumption due to unregulated access to utilization of the resource. In several natural resources' constraints to unlimited and unregulated consumption, (Hardin, 1968) concluded that most common property could be regulated and have limited access to consumption though laws and regulations. Public entities of similar nature could be brought under private ownership with Government holding majority of shares. Other findings showed that fish population were some of the best case studies of *tragedy of commons* because of its ability to decline with time (Hardine, 1968).

2.10 Theories on Forest Resource Use Conflict

The continued degradation of Lembus forest was as a result of a forest resource use conflict involving the local communities and the government. While the former was deprived of its rightful use of homegrown forest resources, the latter was concerned mainly with protection and conservation. Studies had shown that Natural resource use conflicts was real and required an immediate intervention (Poola, 2020). Against this background, Homer-Dixon came up with the theory of eco-violence which could be more relevant to the case of Lembus forest. Unregulated use and limited access to these resources had always led over exploitation, hence reduction in genetic resource base. In these circumstances, the likelihood of conflict was inevitable.

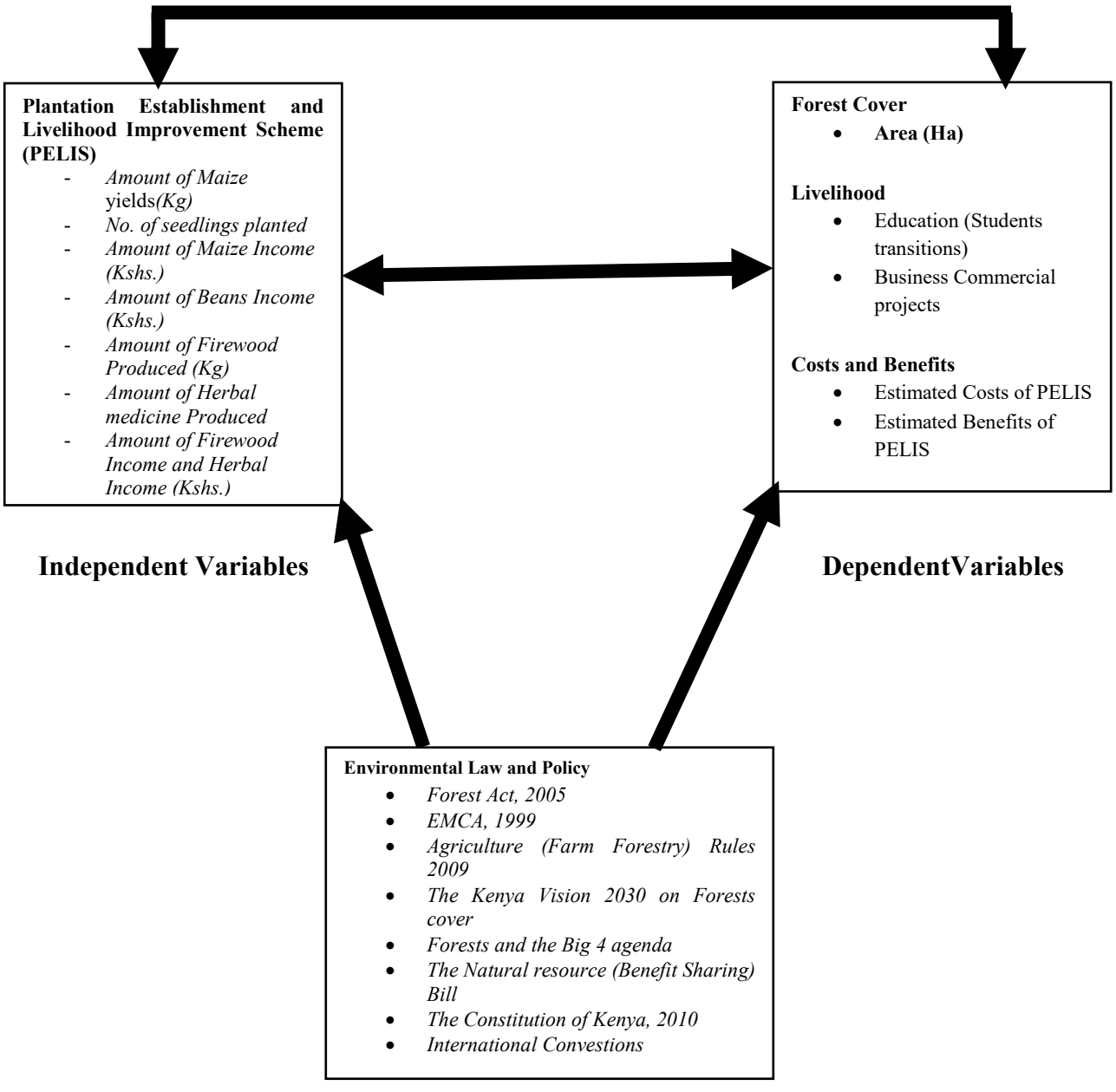
Tobias Ide (2020) further found out that qualitative and quantitative reduction of renewable resources like forests, fish and water could potentially increase the scarcity of the resources. The reduction could have a far-reaching economic effects can be felt both at national or international levels if the three resources were the principal enablers of their economies. Such scarcities, the report added, could trigger conflicts of high proportion.

Apart from depletion or unsustainable exploitation, scarcity could be a function of high population growth, economic development and pollution. Studies showed that natural resource scarcity negatively affected agricultural production. Limited production due to scarcity of such resources had always influenced negatively in several spheres of the society (Gleditsch and

Urdal, 2002) thus forming a fertile ground for conflicts. Reduction of a natural resource that served many livelihood was prone to degenerate into conflicts if the demand increased against a constant resource base (Tobias Ide, 2020). In similar context, in the Lembus Ecosystem, increase in population and surging poverty levels had a great a devastating impact on forests around the area, and this had finally led to misunderstanding between the local community and the Forest administration.Subsequently, the existing forest were threatened by illegal logging and unsustainable exploitation.

2.11 Conceptual Framework of the Study

A Conceptual framework operationalizes variables towards the study objectives (Shikalepo, 2020). Figure 1 shows how the variables were operationalised to address specific objectives.



Intervening Variables

Figure 1: Conceptual Framework

The findings were premised on concept of sustainable forest management. Income from various forests products had positive influence on the key livelihood projects (students' transition and business enterprises). Income and yields of forest products (maize, beans) were the measurable variables under PELIS. The forest products (maize and beans) had a direct contribution to Forest cover in terms of size (Planatation established) and quantity (Seedlings planted). The forest product also had a direct contribution to livelihood in terms of students' transition to secondary school and development projects initiated (commercial buildings, boreholes). The more income and yields from the forest products (PELIS) the more many students enrolled to secondary schools and many more development projects. This concept was derived from the Forest Act, 2005 which provided for increased forest cover and livelihood improvement when the PFM was anchored into it. The forest products too had a direct link with Costs and Benefits (Equity). Income and Yields from the forest would be in favour of the CFAs. It was estimated that the costs incurred by CFAs in production would not be more than the income or profit obtained (Ongugo, 2007). The laws and policies were therefore moderating factors towards production and consumption of forest products. The degraded state of the forest ecosystem might definitely lead to low production of forest products thus affecting the forest cover, livelihood and equity. The state of the environment was therefore a function of the existing laws and regulations that affect its ecological intergrity and provisional services.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The chapter oulines the methodology used throughout the study. It encompasses the study area, research design, population and sampling and data collection procedures. Other components include data analysis and presentations, data reliability and valididty and research ethics.

3.2 Description of Study Area

The study was carried out in all the community forest associations within the eight (8) gazetted forest blocks in Lembus ecosystem.

3.2.1Geographic Location and Size

The Lembus forest ecosystem is part of the Mau forest complex, accounting for about 24% of the entire forest complex. It is lies within latitudes 0°4' S and 0°8' N and longitudes 350°32' E and 350°48' E. The Forest stands at about 2400 m above the sea level and comprises of eight (8) main blocks, namely Chemorgok, Narasha, Maji Mazuri and Sabatia. Others are Koibatek, Chemususu, Esageri and Kiptuget. The total area covered by the eight blocks is 51,007.7 hectares. The vast majority of ecosystem is natural forest mainly dominated by species like *Spathodea nilotica, Warbugua Ugandensis* and *Albizia gummifera. Others are Prunas Africana, Dombeya goetzenii and Juniperus procera* among others species representing about 55% of the total ecosystem. Plantation forestry comprised majorly of fast growing species of *Eucalyptus saligna, Cupressus lusitanica* and *Pinus patula* accounting for about 38% while grassland represents about 7 %(IUCN, 2008). Figure 2 shows the distribution of the eight (8) forest blocks forming the Lembus forest ecosystem.

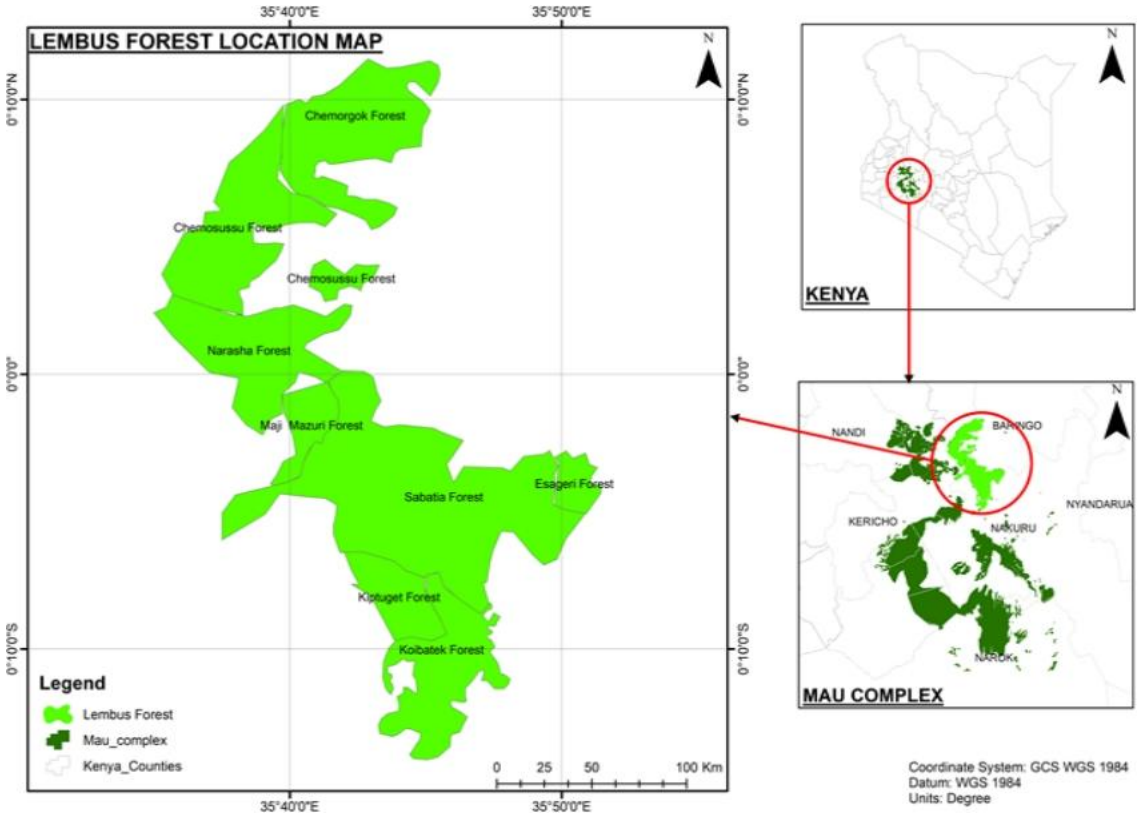


Figure 2: Maps showing the distribution of the eight forest blocks forming the Lembus forest ecosystem and Lembus forest ecosystem within Mau Complex.

Source: Researcher, 2019

3.2.2 Forest Cover in Lembus Forest Ecosystem

Two years after operationalisation of the Forest Act, the forest cover in Lembus accounted for 42%, (22616.6ha) while the glades (agricultural) was 16% or 8,357 ha of the ecosystem land surface. Three years in to the implementation of the PFM, the glades reduced to 13 %, a function participatory approach. However, total forest cover also recorded a drastic reduction to what authorities' attribute to forest fires and increased illegal tree harvesting. This was also attributed to failure to put in place Participatory Forest Management Plans (PFMP) by various CFAs within the forest ecosystem.

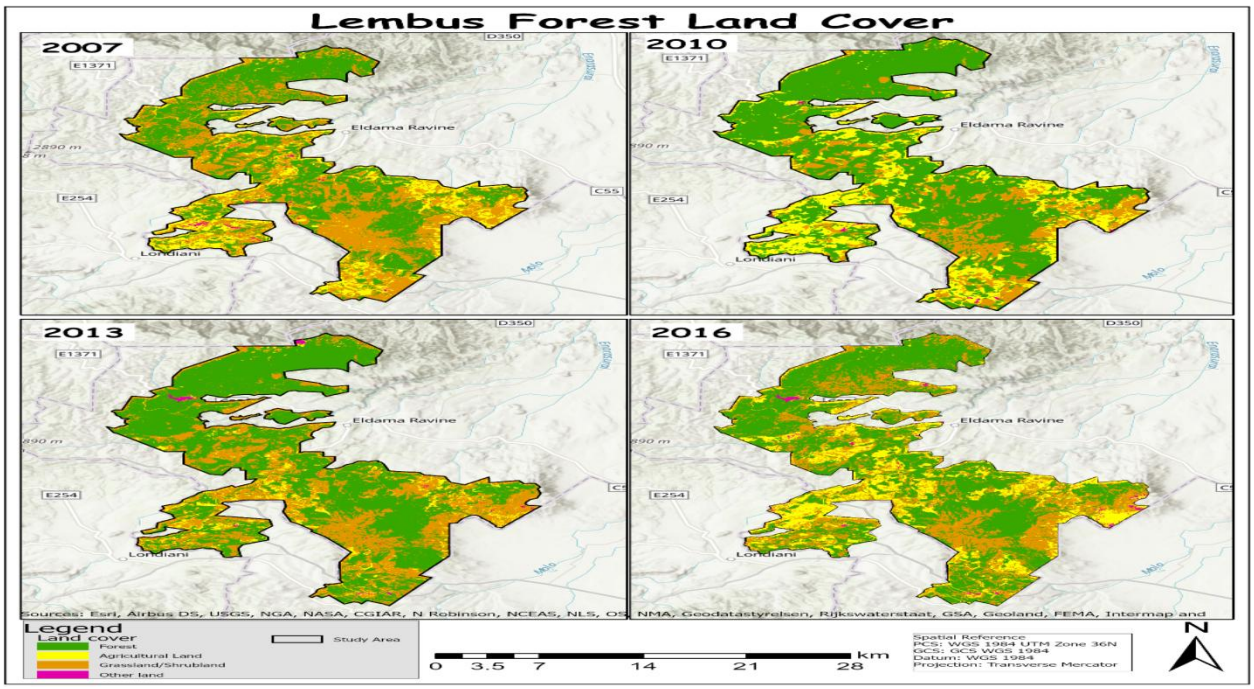


Figure 3: Lembus forest cover, 2007 – 2016
Source: KFS, 2019

3.2.3 Forest blocks in Lembus Ecosystem

3.2.3.1 Chemorgok Forest Block

Chemorgok CFA had a strong 728 memberships, with the responsibility of protecting and conserving their nearby forest, as provided for in the forest act, 2005. At the onset of the operationalisation of the Forest Act in 2007, the forest cover accounted for 81%. After the formation of the CFA and subsequent implementation of PFMP, the forest cover shot from 81% in 2007 to 87.3% in 2019. The increase was attributed to increased participation in the CFAs in the implementation of PFMP, which included successful adoption of PELIS, firewood and herbs collection among other User rights.

3.2.3.2 Chemususu Forest Block

Chemususu CFA had a total membership of 1249. The Ecosystem had a total area of 11,308.8 ha. Before the PFMP was developed in the year 2015, the forestland had a 57% forest cover. The construction of Chemususu dam had ecological effects, including reduction of the area under forest and destruction of indigenous forest and cultural sites. Upon formation and implementation of the PFMP in 2015, the forest cover shot to 80%, thus indicating the

contribution of PFM initiatives like PELIS, grazing, fuel wood and herbs collection. However, illicit destruction and illegal logging remained a major obstacle to forest conservation efforts. However, the forest had reduced by 0.4% since 2007 to 2019 to what Authorities attributed to allocation of land for Chemususu dam.

3.2.3.3 Esageri Forest Block

Esageri CFA had 1585 members protecting a 7.795.5 ha forest, while implementing the PFMP. There was drastic reduction of grassland from 46% in 2007 to 24.8% in 2019. The grassland that existed as glades had since formed part of the forest cover, increasing from 32.5% in 2007 to 48.5 % in 2019. The forest block had suffered massive illegal logging, especially indigenous species like *Juniperus procera* and charcoal burning.Esageri forest had lost about 0.4% of its total land since 2007 to what the authorities attribute to excision.

3.2.3.4 Kiptuget Forest Block

Kiptuget CFA with 1063 members, suffered extensive forest fires before 2007 that resulted into decline of vegetation with increased size of glades that existed as grassland. However, with operationalisation of PFM initiatives through the PFMP developed in 2015, the glades drastically reduced from 75% in 2007 to 7.3% in 2019. Forest cover also shot from 18.3% in 2007 to 76.4% in 2019.These were functions of involvement of CFAs in PFM initiatives as entrenched in the forest Act, 2005. More members were engaged in PELIS, thus influencing positively in the forest cover.

3.2.3.5 Koibatek Forest Block

Koibatek CFA had 2108 members responsible for protecting an 8871.5 ha forest that suffered destruction during post-election violence and subsequent forest fires that saw forest cover diminishing to 27.5% in 2007 but subsequently shot up to 61.9% in 2019. This increment was attributed to implementation of PFMP that was supported by the Slovak government in 2013. Koibatek forest also lost 0.35% of its land since 2007 to what authorities' attribute to excision.

3.2.3.6 Maji Mazuri Forest Block

The CFA had 1361 members managing a forest that suffered illegal farming and encroachment. Maji Mazuri forestland also increased by 41.9% up from 2007. The forestland was 31.2 ha in

2007 and increased to 44.28 in 2019. However, with implementation of the PFMP forest cover shot up from 31.2% in 2007 to 44.3% in 2019.

3.2.3.7 Narasha Forest Block

Narasha CFA charged with responsibility of protecting Narasha forest had shown an improvement of forest cover from 40.8% in 2007 to 44.8% in 2019 thus showing a positive improvement trend with the implementation of PFMP developed by the CFA in 2015. However, the forest lost about 2% of the total area since 2007.

3.2.3.8 Sabatia Forest Block

Before 2007, the forest suffered massive deforestation mainly due to encroachment and illegal logging. However, with the adoption of PFMP developed in 2015 saw a remarkable increment from a meagre 5.5 % in 2007 to 45.8% in 2019. This was attributed to involvement of CFAs into PFM user rights. However, the forest land size increased by 49.3 % since 2007.

3.2.4 Climatic Conditions

Due to its location within the vast Mau forest, Lembus receives a moderate temperature of between 10°C to 24°C. The average annual precipitation ranges between 1200 mm to 1800 mm with long rains occurring between March and July, some times extends to August. This is a function of rainfall unreliability and climate change. Short rains are always expected in September upto November (GoK, 2020). Rainfal intensity always occurs around Londiani Mount Blanket and Masaita Forest blocks. This represents a rainfall reliability of 50%.

3.2.5 Topography

Lembus Forest ecosystem is characterized by unique topographical features, which includes undulating river valley and plains forming seasonal rivers and srteams flowing into Lake Bogoria and Lake Baringo within Baringo Forests Zone.

3.2.6 Participatory Forest Management Plans

The Forest Act, 2005 provided for the development of the Partcipatory forest management Plans (PFMP). It is a forest management tool that oulines how Govermement agencies, Community forest associations collectively manage forest, taking central role in decision-making process. As at 2019, all the CFAs had developed their respective PFMPs. Seven (7) out of eight (8) PFMPs

were developed with support from the DANIDA funded Lembus Intergrated Development Project. The Slovakian Government supported the development of the Koibatek PFMP.

3.2.7 The Socio Economic Activities

Socio economically, the Forest is surrounded majorly by the Lembus clan, a sub tribe of the Kalenjin community. However, in other forest blocks like Maji Mazuri, there is a significant number of the Kikuyu community, who predominantly do small-scale farming and business. Farming, mainly crop growing is done inside the forest. There are also other communities neighboring the forest like the Luos, Ogiek and Luhyas, especially around Maji Mazuri forest. The Kalenjin and Kikuyus have a cultural association with the forest. For example, both communities perform religious activities in the forest. The Kalenjin rely on the forest for the crucial cultural activity of initiating their young men into adulthood (circumcision). The Ogiek has a culture of hunting and gathering within the community. Such sites are largely undisturbed. The surrounding villages use a variety of lumber and other forest goods. These comprise recreational areas, tourist attractions, construction materials, and medicinal plants. The forest serves as a vital source of medicinal plants, contributing to the treatment of local ailments. At the same time, the forest is seen as important recreation area due to well-conserved ecosystem. The main source of energy is wood derived from the Forest.

3.2.8 Road Networks

Bitumen, murram and earth roads were the main roads within the entires Lembus Ecosystem. According to GoK (2013) most of the roads facilitated transport of agricultural coomodities in areas like Torongo, Maji Mazuri and Eldama Ravine.

3.2.9 Poverty Level

Poverty level in Lembus Ecosystem remained as high as 52.12%. Baringo County had been ranked the 32nd County in Kenya in terms of riches/wealth (GoK, 2013). The introduction of participatory forest management within the Forest Act, 2005 was an enabler of economic empowerment to the local community because it addressed primarily improved forest cover and livelihood status (GoK, 2005).

3.2.10 Criteria used in Selection of the Study Area

An analysis of major forest ecosystems in the country-depicted similarity in socio economic and ecological characteristics to the study area, Lembus forest ecosystem. This therefore qualified the forest ecosystem to be nationally representative to inform this socio economic and ecological study. Although there were slight variations in altitude, in Northern Kenya forest ecosystems like Marsabit, it could insignificantly change the national representation. All the forest communities in Kenya largely undergo similar socio-economic predicaments.

3.3 Research Design

The research was based on a cross-sectional design. The observational approach employs data from a sample to assess the conditions of a broad population (Setia, 2016). Cross-sectional studies are characterized by observations conducted at a particular time (Zangirolami-Raimundo *et al.,* 2018). The Design was considered suitable, as this study entailed gathering data at a single point in time. The primary benefit of the design was that it facilitated the researcher's acquisition of respondent participation and allowed for data collection etc. This rendered data collection more economical regarding time and expense. It also presented actual statistics at a certain moment, namely the current food production under PELIS. This underscores the suitability of this investigation. The approach provided a better platform to describe the characteristics of forest communities in relation to other stakeholders in the co-management of forest resources.

3.4 Target Population

The target population consisted of all households (CFAs) which benefit from Lembus forest resource. The target population was ten thousand and four households distributed among the 8 CFAs as follows: Narasha CFA had a total of 1256 households, Chemorgok had 728 households while Chemususu had 1249 houdeholds. Others were Koibatek, Kiptuget, Maji Mazuri, Esageri and Sabatia at 2108, 1063, 1361, 1585 and 654 households respectively.

3.5 Sampling Techniques

In this study, a sample size of 384 households were used to provide the information to enable the study achieve its objectives. Fischer's (1998) formula was used in the determination of sample size;

$n = Z2\ p\ (1-p)/e2;$

Let n be the smallest sample size needed for a population bigger than 10,000, Z be the standard normal deviation for the given confidence level (set at 1.96 for the 95% confidence level used in this study), p be the estimated percentage of the population that has a certain trait (a value of 50% or 0.5 is fine if there isn't a good estimate), and e be the level of precision or sampling error at the 95% confidence level, with 0.05 being the value for e (Glenn, 1992). This was calculated as n = (1.96)2(.5×.5)/ (.05)2 =384.2 ≈ 384 CFA members.

To ensure distribution of equal sample from each of the eight CFAs, stratified sampling technique was applied. Neyman's method, $n_h = \left(\frac{n}{N}\right) N_h$ of proportional allocation where n_h is the stratum sample size; n is the sample size for the study; N is the target population and; N_h is the stratum population (Lavrakas *et al,* 2019) was used to determine the sample size for each CFA. The study employed purposive sampling to identify the starting household and later used purposive sampling at every fourth household. Table 1 shows the sampled population.

Table 1: Community Forest Associations (CFA) in eight forest blocks, number of households and the sample size

CFAs	Households (N)	Sample size (n) (Households)
Narasha	1256	48
Chemorgok	728	28
Chemususu	1249	48
Koibatek	2108	81
Kiptuget	1063	41
Maji Mazuri	1361	52
Esageri	1585	61
Sabatia	654	25
TOTAL	10,004	384

Source: KFS, 2019

3.6 Data collection Procedures

The study applied both primary and secondary data.

3.6.1 Primary Sources of Data

3.6.1.1Measurement of Forest Cover

Scrutiny of PELIS register in forest stations in Lembus. Every CFA member was allocated a mimimum of 1.6 acres of the forest to plant tree seedlings together with either maize or beans. Every registered CFA member (N= 1004) planted seedlings within the provided 1.6-acre piece of forest.

3.6.1.2 Questionnaires

Quessionnaires were developed and administered to 384 respondents in all the eight forest blocks. The number of respondents was proportionately distributed to the CFAs each representing one-forest block as shown in Table 1 above.

3.6.1.3 Focused Group Discussions (FGDs)

Focus Group Discusions were held in all the eight (8) Community Forest Associations. Each CFA was represented by 10 members. This was in accordance to Escalada and Heong (2010) that required at least 8 to 10 participants to form a credible FDG, with a distribution of atleast 6 men and 4 women, while youths to be represented by 2 members.

3.6.1.4 Key Informant Interviews

The Key informants were largely drawn from serving government officers in the Kenya forest Service, Ministry of Agriculture, CFA leadership. Others were the representatives from the Commnity Based Organizations, Women and Youth groups operating in the study area. Therefore, key informants who were interviewed during the study included 1 County Forest Conservator. 1 Sub county Director of Education, 1 County Director of Agriculture, 1 County Director of Environment (NEMA), 1 County Director of Environment (County Government) and I representatives of CFAs, CBOs and Groups.

3.6.2 Secondary Sources of Data

Sources of Secondary data were from Participatory forest management plans (PFMPs), Forest Management Plans (FMPs). A number of legal documents were verified, including the Forest Act, 2005, Environment Management and Coordination Act (EMCA, 2009), The Constitution of Kenya, 2010 among others. Also reviewed were the registeres of the CFA from 2015 to 2019. Others included United Nations Bulletin Reports, Government gazette documents and lots of

published and unpublished literature. The sccondary data were obtained on forest sizes in hectares for the years 2015 to 2019. The 8 forests blocks sampled within Lembus ecosystem which included: Esageri, Sabatia, Maji Mazuri, Kiptuget, Koibatek, Chemususu, Narasha and Chemorgok. In addition, the numbers of tree seedlings planted in these forests for the years 2015 to 2019 were obtained. The data were also acquired for forests products yields and forest products income for the 8 forest blocks for years 2015 to 2019.

3.7 Data Analyses

A codebook was developed to capture data on household heads using questionnaires. Focus Group Discussions and key informants interview were the main platform of collecting data and information. A codebook is a document that delineates the methodology of data coding and the corresponding codes maintained in a computer-readable manner (Pallant *et al.,* 2016). The codebook was then used to code the collected data and finally cleaned data was subjected to Statistical Package for Social Science (SPSS) computer application. The data files were screened for errors and cleaned before analysis was conducted. Visual evaluations were conducted to detect mistakes in data entry for each variable. We employed range checks to identify invalid and anomalous values. Qualitative data was generated by FGDs, interviews and open-ended items were organized into themes pertinent to the study objectives.

In objective one that dealt with determinition of the contribution of Forest plantation establishment scheme (number of tree seedlings planted) to forest cover (hectares) in Lembus ecosystem. Spearman Rank Correlation coefficient r or *p* was used to measure the strength and direction of the correlation between PELIS (No. of seedlings planted) and forest cover in hectares. The contribution was measured by effect size (practical significance) according to Cohen's guidelines (1992) to the absolute value of r.

Small effect: r = between 0.10 and 0.29

Medium effect: r = between 0.30 and 0.49

Large effect: r = 0.50 or higher

In objective two, Spearman Rank Correlation coefficient *r* was also used to determine the contribution of Forest Product Yields in Kgs (maize and beans) to forest cover in hectares in 8 forest blocks in Lembus forest ecosystem. The contribution was also measured using Cohen's guidelines (1992).

In objective three, which dealt with determination of Forests product yields on the livelihood, Spearman Rank Correlation was used. The approach was used because it effectively assessed the relationship between continuous variables and clarified the impact of explanatory variables on variations in the outcome. Another advantage was its capacity to facilitate the examination of interrelationships among a collection of variables, making it suitable for investigating complicated real-world research problems. It gives a more precise view of correlation between variables by taking into account the added factors that are related to the dependent variable.In estimation of significant difference in production and sales within PELIS, Analysis of Variance was also performed to examine if there was a significant difference in production and sales across all the CFAs between 2015 to 2019.

The fourth objective on cost and benefit on PELIS, the T-test was chosen because it was ideal for comparing the means of continuous variables of two independent sample groups (Pituch and Steven, 2016). The test was deemed appropriate because it involved comparing the estimated cost and benefits of PFM. Tools were developed to capture crop production trend between 2015 to 2019. The respondents were given opportunity to suggest on how the proceeds could be used to improve their livelihood. Building of infrastructure, school fees, construction of water projects etc. Respondents provided ways or methods which could be used to share forest proceeds. Both qualitative and quantitative techniques were utilized in the analysis of collected data. Secondary data and information were used as benchmark for comparison on equitable consumption of forest resources.

On the fifth objective on policies and legislatives, a checklist was developed to capture all the policies and legislations as reflected in various Acts of Parliament addressing forest matters and discussed in a Focus Group Discussion (FGDs). Chi Square analysis on Consistency of Awareness on Policy and Legislation gaps was used. It was also used for testing relationships between categorical variables thus establishing consistency in awareness and unawareness on existing issues of general public. The views of stakeholders like the County government, local leaders was collected on policy intervention to improve major components of PFM like forest cover, livelihood and equity.

3.7.1 Pilot Testing and Reliability of the Questionnaire

According to Thomas V, *et al*., (2015), a sample size of between 30 – 50 participants is recommended for pre-testing a quessionnare. The instrument was pre-tested using a sample of 30 households that were randomly selected from the study sites for piloting. Piloting of the instrument was necessary to assess its effectiveness and reliability using Coronach reliability coefficient. A reliability coefficient of 0.72 was preferred. Cronbach reliability coefficient was the most frequently reported internal consistency estimate other than Kuder – Richardson – 20. Reliability should be at least 0.70 or preferably higher for research purposes (Fraenkel and Wallen, 2000). A high coefficient (0.7 and above) implied that items correlate highly among themselves.

3.7.2 Research Ethics

Maseno University granted approval for the research, and the Government of Kenya issued a research permit. The researcher guaranteed the participants' anonymity by not requiring them to provide their names or identities on the surveys. Special precautions were taken with respect to vulnerable populations and the benefits and burdens of research was distributed fairly. Data, results, methods and procedure followed in conducting research were reported with utmost honesty to avoid any misrepresentation. All forms of bias were eliminated in the research design, data analysis, data interpretation, and other elements necessitating objectivity. Meticulous records of research activities, including data collection and research design, were maintained to reduce errors. The researcher was open in sharing of data, ideas, tools, resources and any positive criticism and new ideas were accepted and incorporated in the research. All contributors to research were adequately acknowledged and any form of plagiarism would be avoided as much as possible. The research was impartial about ethnicity, gender, race, or any criteria unrelated to scientific skill and integrity. Both the researcher and respondents maintained an absolute agreement on oath to maintain confidentiality of the data collected.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

The chapter provided results, interpretation, analysis and discussion on: Contribution of PELIS (number of tree seedlings planted) to forest cover in Lembus forest ecosystem; contribution of PELIS (forest product yields) to forest cover in Lembus, contribution of PELIS (forests products income) to the CFA livelihoods; Costs and benefits of PELIS in Lembus forest ecosystem; and contribution of Policy and Legislation to livelihood, forest cover and equity in Lembus CFAs.

4.2 Contribution of PELIS (Number of Tree Seedlings Planted) to Forest Cover in Lembus Forest Ecosystem

4.2.1 Size of Forest Planted (Forest Cover) under PELIS in 8 forest blocks in Lembus Forest Ecosystem

The size of forests planted (forest cover) under PELIS were estimated in 8 forest blocks, namely, Esageri, Sabatia, Maji Mazuri, Kiptuget, Koibatek, Chemususu, Narasha and Chemorgok within Lembus forest ecosystem for the years 2015 to 2019. The results are presented in Table 2.

Table 2: Size of forests planted (forest cover) under PELIS from 2015 to 2019 in eight forest blocks in Lembus forest ecosystem

CFAs	2015 (Ha)	2016 (Ha)	2017 (Ha)	2018 (Ha)	2019 (Ha)	Total (Ha)	% of Forest under PELIS
Esageri	288.9	297.6	311.4	314.4	317.7	1,530.0	20.0
Sabatia	121.9	124.5	127.1	129.8	132.4	635.7	15.4
Maji Mazuri	248.0	256.3	264.6	270.1	275.6	1,314.6	22.0
Kiptuget	93.16	107.3	118.2	129.1	150.6	598.3	70.0
Koibatek	392.6	405.6	414.1	422.6	422.6	2,061.7	23.0
Chemususu	240.3	245.4	247.8	250.4	252.9	1,236.8	11.0
Narasha	229.0	241.5	249.0	251.9	254.3	1,225.9	20.0
Chemorgok	132.6	135.6	140.1	144.5	146.0	698.8	12.0
Total	1,746.4	1,813.8	1,872.3	1,912.8	1,956.3	9301.8	24.1

Source: Researcher, 2019

About 24.1% of the forests land had been replanted by the exotic tree species of *Pinus patula, Cuppressus lusitanica and Eucalyptus saligna.* The three species also had high economic value

upon maturity. The rotation age for the three species ranged from 10 to 30 years, depending the plantation objectives. *Cupressus lusitanica* and *Pinus patula,* for example, had largely been used as sawn timber. The results show that the highest percentage of forest area under PELIS was in Kiptuget (70%) followed by Koibatek (23%), Maji Mazuri (22%), Esageri (20%), Narasha (20%), Sabatia (15.4%), Chemorgok (12%) and Chemususu (11%). This was a function of active participation of CFAs into PELIS because most of them had already developed and signed participatory forest management plans. Kiptuget, for example had the highest rate, because it was the first forest to develop the PFMP, thus gave them an advantage in compliance unlike the others. GoK, (2018) had reported slow participation of CFAs into PELIS because of compliance requirements by the Forest authorities, like registration by the Registrar of Societies.

4.2.2 Number of Tree Seedlings Planted in 8 Forest Blocks under PELIS in Lembus Forest Ecosystem

The number of tree seedlings planted in the eight forest blocks by Community Forest Associations (CFAs) from 2015 to 2019 were estimated. The data are presented in Table 3.

Table 3:The Number of Tree Seedlings Planted by CFA under PELIS for the Years 2015 to 2019 in Eight Forest Blocks in Lembus Forest Ecosystem

CFAs	2015	2016	2017	2018	2019	Total
Esageri	1,141,600	1,204,000	1,230,400	1,242,400	1,255,200	6,074,400
Sabatia	481,600	492,000	502,400	512,800	512,800	2,512,000
Maji Mazuri	980,000	1,012,800	1,045,600	1,067,200	1,088,800	5,194,400
Kiptuget	765,600	799,200	833,600	841,600	850,400	4,090.400
Koibatek	1,551,200	1,602,400	1,636,000	1,669,600	1,686,400	8,145,600
Chemususu	949,600	969,600	979,200	989,600	999,200	4,887,200
Narasha	904,800	954,400	984,800	995,200	10,004,800	4,844,000
Chemorgok	524,000	536,000	553,600	571,200	576,800	2,761,600

Source: Researcher, 2019

The results (Table 3) showed a steady increase of tree seedlings survival from 2015 to 2019. The increment was a function of compliance with the Government's policies of development and operationalisation of PFMP. The three preferred species were *Pinus patula, Cupressus lusitanica* and *Eucalyptus saligna.* The increment in plantation establishment was a function of active number of CFA members involved in tree planting. Koibatek forest, for example, had a highest number of its members in active participation. There had also been conflicts on forest resource

use within the ecosystem for a number of years, and this contributed to low performance by other CFAs (GoK, 2007). Chemorgok forest, for example had suffered a 33.6% forest size reduction due to what the Forest authorities attributed to illegal encroachment.

4.2.3 Association between Number of Tree Seedlings Planted and Forest Cover (Size of Forest Planted) in Lembus Forest Ecosystem

The Spearman's rank correlation coefficients were calculated to measure the association between number of seedlings planted under PELIS and (size of forests planted (forest cover) in eight forest blocks in Lembus Forest ecosystem for the years 2015 to 2019. The pairwise correlation coefficients (Table 4) showed consistent positive and statistically significant correlation between the size of forest planted under PELIS and the number of seedlings planted in the years 2015 to 2019. The correlation coefficients (*p*) are positive and within the interval of 0.905 and 1.000, which implied that the growth in the forest area is directly proportional to the growth in the number of seedlings planted over the five years.

These high coefficients that were found to be consistent over years indicate that there was a predictable and similar trend, with only minor changes observed in previous years (p = 0.905–0.929) to an intensified correlation in 2019. Taken together, these results support the strength of the association between land area assigned to forest planting and the extent of the seedling planting, which supports the efficiency of PELIS in the correlation of the forest extension and seedlings growth. This explains the relationship between the number of CFAs and the output of their production. Koibatek forest demonstrated the leading CFA with high number of seelings planted because of the number of its members involved in the activity. The results are consistent with thoseobserved in Tanzania where PFM influencedhigh tree forest quality following active engagement of the forest communities in the joint forest management with the Government (Kajembe *et al.*, 2005).

Table 4: Pairwise Spearman Rank correlation coefficients p between numbers of seedlings planted under PELIS and size of forest planted in hectares (forest cover) in eight forest blocks in Lembus forest ecosystem

Spearman's rho		No. Seedlings Planted in 2015	ofNo. Seedlings Planted in 2016	ofNo. Seedlings Planted in 2017	ofNo. Seedlings Planted in 2018	ofNo. Seedlings Planted in 2019	of
Size of forest planted in 2015	Correlation (Ha)Coefficient	.929**	0.929**	0.905**	0.905**	0.905**	
	Sig. (2-tailed)	.001	.001	.002	.002	.002	
	N	8	8	8	8	8	
Size of forest planted in 2016	Correlation (Ha)Coefficient	.929**	.929**	.905**	.905**	.905**	
	Sig. (2-tailed)	.001	.001	.002	.002	.002	
	N	8	8	8	8	8	
Size of forest planted in 2017	Correlation (Ha)Coefficient	.905**	.905**	.929**	.929**	.929**	
	Sig. (2-tailed)	.002	.002	.001	.001	.001	
	N	8	8	8	8	8	
Size of forest planted in 2018	Correlation (Ha)Coefficient	.905**	.905**	.929**	.929**	.929**	
	Sig. (2-tailed)	.002	.002	.001	.001	.001	
	N	8	8	8	8	8	
Size of forest planted in 2019	Correlation (Ha)Coefficient	.976**	.976**	1.000**	1.000**	1.000**	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	8	8	8	8	8	

**. Correlation is significant at the 0.01 level (2-tailed).

According to Cohen's guideline (1992), a correlation coefficient r or $p = 0.5$ and higher has large effect size. Thus, a correlation coefficient $p = 0.905$ and above (Table 4) exhibit a large effect size, that is, large practical significance. Apparently, there is a large contribution of PELIS (number of tree seedlings planted) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem. The large effect size underscored the effectiveness of community involved reforestation programs in restoring degraded forest ecosystems.

Kagombe, *et al.*, 2004 also confirmed that a number of plantations within gazetted forests had been established through PELIS. Gobeze et *al.*, (2009) also found out that PFM had the potential to increase vegetation cover through species abundance and diversity however, social economic, ecologic and cultural aspects of riparian communities vary from one country to another and this may affect the overall outcome of the PFM in specific areas.

4.3 Contribution of PELIS (Forest Products Yields) to Forest Cover in Lembus Forest Ecosystem

4.3.1 Maize yields Obtained in Eight Forest Blocks under PELIS in Lembus Forest Ecosystem

The mean annual maize yields in kilograms obtained by community forest associations in eight forest blocks under PELIS for the years 2015 to 2019 were estimated (Table 5).

Table 5: Mean annual maize yields (Kg) received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

	Year				
CFA	**2015**	**2016**	**2017**	**2018**	**2019**
Chemususu	4,677	1,952	4,918	7,494	25,139
Sabatia	8,365	9,254	9,123	9,090	10,332
Maji mazuri	13,600	16,320	27,000	54,000	61,245
Narasha	12,560	18,735	24,980	31,225	37,470
Koibatek	21,080	31,620	42,160	52,700	63,240
Chemorgot	1,456	3,640	5,824	7,280	10,920
Kiptuget	2,126	5,315	8,504	10,630	15,945
Esageri	3,585	7,925	12,680	15,850	23,775

Source: Researcher, 2019

The results (Table 5) show a gradual increase in maize yields between 2015 to 2019. The increment was a function of increased participation of CFAs and operationalization of PFMPs. Increased production was a function increased participation of CFAs, thus more land in the forest was brought under PELIS, hence more production. Favorable climate was another key factor in beans production (moderate rainfall intensity).

4.3.2 Bean Yields Obtained In Eight Forest Blocks under PELIS in Lembus Forest Ecosystem

The mean annual bean yields in Kilograms obtained by community forest associations in eight forest blocks under PELIS in Lembus forest ecosystem for the years 2015 to 2019 are presented in Table 6.

Table 6: Mean annual bean yields (Kg) received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

CFA	2015	2016	2017	2018	2019
Koibatek	18,900	37,980	56,880	66,330	151,740
Sabatia	14,760	29,430	15,030	19,620	23,580
Chemorgong	6,570	11,520	17,010	18,270	19,620
Kiptuget	11,520	14,310	19,170	23,940	28,710
Maji Mazuri	12,240	15,300	20,340	24,480	30,600
Narasha	11,340	22,590	33,930	45,180	113,040
Chemususu	10,530	14,040	21,060	18,270	19,620
Esageri	10,800	16,200	24,000	19,200	20,600

Source: Researcher, 2019

The results (Table 6) show a gradual increase in beans yields between 2015 to 2019.Like maize yield, beans similarly recorded high production between the same periods (2015 – 2019). These were functions of active CFA participation through development of PFMPs.

4.3.3Association between Annual Maize Yields and Size of Forests Planted (Forest Cover)

The Spearman's rank correlation coefficients were calculated to measure the association between maize yields (Table 5) and size of forests planted (Table 2) in eight forest blocks in Lembus Forest for the years 2015 to 2019. The pairwise correlation coefficient results are presented in Table 7.

Table 7: Pairwise Spearman rank correlation coefficients p between size of the forest planted and annual mean maize yields for the years 2015 to 2019 in eight forest blocks in Lembus forest ecosystem

Spearman's rho		Maize yields 2015	Maize yields 2016	Maize yields 2017	Maize yields 2018	Maize yields 2019
Size of forest planted (Ha) in 2015	Correlation Coefficient	.571	.429	.595	.571	.762*
	Sig. (2-tailed)	.139	.289	.120	.139	.028
	N	8	8	8	8	8
Size of forest planted (Ha) in 2016	Correlation Coefficient	.571	.429	.595	.571	.762*
	Sig. (2-tailed)	.139	.289	.120	.139	.028
	N	8	8	8	8	8
Size of forest planted (Ha) in 2017	Correlation Coefficient	.619	.571	.714*	.667	.786*
	Sig. (2-tailed)	.102	.139	.047	.071	.021
	N	8	8	8	8	8
Size of forest planted (Ha) in 2018	Correlation Coefficient	.619	.571	.714*	.667	.786*
	Sig. (2-tailed)	.102	.139	.047	.071	.021
	N	8	8	8	8	8
Size of forest planted (Ha)in 2019	Correlation Coefficient	.571	.548	.714*	.762*	.857**
	Sig. (2-tailed)	.139	.160	.047	.028	.007
	N	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The results of the pairwise Spearman rank correlation coefficients in Table 7 reveal that the association between the size of forest planted under PELIS and annual mean maize yields during the years 2015 to 2019 is generally positive (moderate to very strong, i.e, p = 0.429 and p = 0.857), respectively. Although the correlations between 2015 and 2016 are positive but non-significant (p = 0.429 - 0.595, p > 0.05), the influx of stronger and significant relationships can be observed in the following years. More precisely, in 2017 and 2018, the maize production correlated with the respective p =0.714 (p = 0.047) and p = 0.667 (p = 0.071) correlations are significant, indicating a positive trend, whereas only in the former case is the correlation significant at the 0.05 level. The relationship is especially strong in 2019, and coefficients include 0.714 to 0.857, with the latter being significant with the level of 0.01 (p = 0.007). These results indicated that although the correlation between forest size and maize production was relatively weak and irregular in the early years of the study, the correlation increased steadily and became more statistically significant as the years went by indicating that expansion of forest

cover planting under PELIS was possibly growing important as a contributor to enhanced maize yields more so as the years lapsed.

According to Cohen's guideline (1992), a correlation coefficient r or $p = 0.5$ and higher has large effect size and $p = 0.30$- 0.49 has medium effect size. Thus, the highest correlation coefficient $p = 0.857$ (Table 7) exhibit a large effect size, that is, large practical significance. However, the lowest correlation coefficient, $p = 0.429$ shows medium effect size and hence meduim contribution. Apparently, there were medium to large contribution of PELIS (annual mean maize yields) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem.

In concurrence with the findings, Agevi *et al*., (2016) similarly found a massive increase in Malava forest cover under PELIS that was predominantly maize and beans. The forest cover increment was evidenced between 2001 to 2016 with an initial size of 366 ha and 481ha respectively replanted. In conclusion, this explained the potential of PELIS on forest cover improvement as was anticipated by the Forest Act, 2005.

4.3.4 Association between Annual Bean Yields and Size of Forests Planted (Forest Cover)

The Spearman's rank correlation coefficients were calculated to measure the association between bean yields (Table 6) and size of forests planted (Table 2) in eight forest blocks in Lembus Forest for the years 2015 to 2019. The pairwise correlation coefficient results are presented in Table 8.

Table 8: Pairwise Spearman rank correlation coefficients p between size of the forest planted and annual mean beans yields for the years 2015 to 2019 in eight forest blocks in Lembus forest ecosystem

Spearman's rho		Beans yields 2015	Beans yields 2016	Beans yields 2017	Beans yields 2018	Beans yields 2019
Size of forest planted (Ha) in 2015	Correlation Coefficient	.167	.357	.762*	.287	.287
	Sig. (2-tailed)	.693	.385	.028	.490	.490
	N	8	8	8	8	8
Size of forest planted (Ha) in 2016	Correlation Coefficient	.167	.357	.762*	.287	.287
	Sig. (2-tailed)	.693	.385	.028	.490	.490
	N	8	8	8	8	8
Size of forest planted (Ha) in 2017	Correlation Coefficient	.214	.452	.810*	.419	.419
	Sig. (2-tailed)	.610	.260	.015	.301	.301
	N	8	8	8	8	8
Size of forest planted (Ha) in 2018	Correlation Coefficient	.214	.452	.810*	.419	.419
	Sig. (2-tailed)	.610	.260	.015	.301	.301
	N	8	8	8	8	8
Size of forest planted (Ha) in 2019	Correlation Coefficient	.262	.405	.881**	.527	.527
	Sig. (2-tailed)	.531	.320	.004	.180	.180
	N	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The pairwise correlation coefficient results (Table 8) indicate that the correlation between the sizes of forest planted under PELIS and annual mean bean yields during the 2015 to 2019 period is overall positive and differs in magnitude and statistical significance over the years. The correlations of the first two years (2015 and 2016) are weak to moderate (p = 0.167 to p = 0.357) and insignificant (p> 0.05), implying that there is not much or no significant relationship between forest cover and bean yields in the first two years of the study (2015 to 2016). From 2017, however, the correlations became strong, with the coefficients between 0.762 and 0.881, and both 2017 (p = 0.810, p = 0.015) and 2019 (p = 0.881, p = 0.004) have proven statistically significant. These findings reveal that during the later years, greater extent of forest planting was strongly and significantly linked with an increase in bean yields which implies that there was a larger effect because the impacts of the large size of forest area on agricultural output were felt later. Overall, although the relationship was weak and inconsistent during the initial years, it

became strong and statistically significant positive in 2017 and 2019, which indicates the possible long-term contribution of forest expansion under PELIS to the outcome of bean production.

According to Cohen's guideline (1992), a correlation coefficient r or $p = 0.5$ and higher has large effect size, $p = 0.30$- 0.49 has medium effect size, and p = 0.10 - 0.29 has small effect size. Thus, the highest correlation coefficient $p = 0.881$ (Table 8) exhibit a large effect size, that is, large practical significance. However, the lowest correlation coefficient, $p = 0.167$ shows small effect size and hence small contribution. While p =0.357 shows medium effect size and hence medium contribution. Apparently, there were small to medium to large contributions of PELIS (annual mean beans yields) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem. Similar results were also recorded in Ethiopia, Bonga Forest, where a significant improvement of forest cover was observed under PELIS leading to increased vegetation structure and a healthy population (Gobeze *et al*., 2009). Other studies done in Ethiopia, i.e. Gautam *et al*., (2004) showed that the impacts of PFM had resulted in a decline in rate of deforestation and forest degradation.

4.4 Contribution of PELIS (Forests Products Income) to the CFA Livelihoods in Lembus Forest Ecosystem

4.4.1 Forest Products Income in Lembus Forest Ecosystem

4.4.1.1Maize Income Obtained for the Years 2015 To 2019 in Lembus Forest Ecosystem

Table 9 shows mean annual maize yields in kilograms obtained by community forest associations in eight forest blocks under PELIS for the years 2015 to 2019 in Lembus forest ecosystem.

Table 9: Mean annual maize income in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

CFA	2015	2016	2017	2018	2019
Chemususu	9,735.00	4,063.00	10,237.00	15,600	52,330.00
Sabatia	33,255.00	36,789.00	36,267.00	36,137.00	41,075.00
Maji mazuri	25,980.00	31,177.00	51,579.00	103,159.00	117,000.00
Narasha	26,000.00	38,782.00	51,710.00	64,637,00	77,565.00
Koibatek	26,000.00	39,000.00	52,000.00	65,000.00	78,000.00
Chemorgot	5,200.00	13,000.00	28,800.00	26,000.00	39,000.00
Kiptuget	5,200.00	13,000.00	20,800.00	26,000.00	39,000.00
Esageri	6,047.00	13,000.00	20,800.00	26,000.00	39,000.00

Source: Researcher, 2021

Table 9 above also shows a gradual increment in maize income from 2015 – 2019. This was attributed to rainfall reliability within the ecosystem and development of Participatory forest management plans and active implementation of the same. It was found that most parents supply schools with bags of maize that was later used as school fees. Information from the supplies department from most of schools indicated that majority of maize suppliers were parents. This move made a number of parents take their children to school in large numbers following the introduction of forests farming (PELIS). To achieve sustainable yield output within PELIS, Matiku *et al*., (2013) in a study in Taita Hills found out that PELIS could be diversified to produce more products that meet public demand.

4.4.1.2 Beans Income Obtained for the Years 2015 to 2019 in Lembus Forest Ecosystem

Table 10 shows mean annual beans yields in kilograms obtained by community forest associations in eight forest blocks under PELIS for the years 2015 to 2019 in Lembus forest ecosystem.

Table 10: **Mean annual beans income in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019**

CFA	2015	2016	2017	2018	2019
Koibatek	126,400.00	253,600.00	379,200.00	441,600.00	1,012,000.00
Sabatia	98,400.00	196,000.00	100,000.00	131,200.00	157,600.00
Chemorgong	43,200.00	76,800.00	113,600.00	121,600.00	131,200.00
Kiptuget	76,800.00	95,200.00	128,000.00	160,000.00	192,200.00
Maji Mazuri	81,600.00	102,400.00	136,000.00	163,200.00	204,000.00
Narasha	76,000.00	210,400.00	210,400.00	221,600.00	753,600.00
Chemususu	70,400.00	93,600.00	140,000.00	116,800.00	212,800.00
Esageri	68,200.00	95,800.00	142,000.00	118,200.00	200,400.00

Source: Researcher, 2021

Like maize, beans production also showed positive results from 2015 to 2019. The beans income was also used as fees to many students in the forest riparian community. The gradual increment was due to development of PFMPs and active CFAs involvement in PELIS.

4.4.2 Livelihood Projects under PELIS in Eight Forest Blocks in Lembus Forest Ecosystem

4.4.2.1 Students Transition from Primary to Secondary Schools

One of livelihood projects to be supported by forest products income was financing transition of students from primary schools to secondary schools. The number of students supported for the years 2015 to 2019 are presented in Table 11 below.

Table 11: Number of students who transited from primary to secondary schools supported by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

CFA	2015	2016	2017	2018	2019
Chemususu	302	353	361	446	478
Sabatia	61	71	73	90	96
Maji mazuri	363	423	434	535	574
Narasha	242	282	289	357	383
Koibatek	484	565	578	714	766
Chemorgot	121	141	145	178	191
Kiptuget	182	212	217	268	287
Esageri	423	494	506	624	670

Source: Researcher, 2021

Table 11 above shows a gradual increment of transition of students from primary to secondary school from the year 2015 to 2019. The increment was a function of income from maize and beans within PELIS. The more the income increased, the more the transitionas indicators of improved transition shown in Table 11 above.

4.4.2.2 Construction of commercial buildings and boreholes

The other livelihood projects supported by forest products income were the construction of commercial buildings and boreholes by the community forest association. The number of commercial buildings and boreholes combined supported for the years 2015 to 2019 are presented in Table 12.

Table 12: Number of commercial buildings and boreholes constructed which were supported by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

CFA	2015	2016	2017	2018	2019
Chemususu	35	54	61	68	74
Sabatia	7	11	12	14	15
Maji mazuri	42	65	73	81	89
Narasha	28	43	48	54	59
Koibatek	56	86	97	108	119
Chemorgot	14	26	24	27	30
Kiptuget	21	32	36	41	45
Esageri	47	75	85	95	104

Source: Researcher, 2021

Between 2015 to 2019, there was a gradual increase in most of the development projects as shown in Table 12 above. The incement also corresponds with the pattern of income from maize and beans during the same period. This confirms Wambugu *et al.,* 2018, who found out that PFM had improved the socio economic status of the forests communities based on the ecosystem services obtained. The study revealed that about 83% of the forest community befitted from maize income that subsequently supported a number of development projects in area. Forest farming, income therefore indicated a growing socio economic status of the local community.

4.4.2.3 Income Obtained from Medicinal Herbs for the Years 2015 to 2019 in Lembus Forest Ecosystem

Table 13 shows mean annual income from medicinal herbs in Kenya Shillings obtained by community forest associations in eight forest blocks under PELIS for the years 2015 to 2019 in Lembus forest ecosystem.

Table 13: Mean annual income from medicinal herbs in Kenya Shillings received by community forest associations (CFA) in eight forest blocks in Lembus forest ecosystem for the years 2015 to 2019

CFA	2015	2016	2017	2018	2019
Chemususu	7,800	8,840	9,880	11,440	11,960
Sabatia	9,360	10,400	10,920	11,440	13,000
Maji mazuri	10,920	11,284	11,700	13,000	13,520
Narasha	8,840	10,400	7,800	9,360	10,400
Koibatek	8,320	9,100	10,140	12,480	13,520
Chemorgot	10,400	10,920	11,960	13,000	14,560
Kiptuget	9,880	10,504	11,180	11,700	11,960
Esageri	11,440	11,700	11,960	12,840	12,740

Source: Researcher, 2021

Like maize and beans, income from herbs also showed a positive outcome. The results show an increment of income from 2015 to 2019. This was attributed the number of CFA members engaged in the business and further the development of PFMPs which provided for the sustainable exploitation of forest products under User rights agreement.

4.4.3Association between Forest Products Income and Livelihood Projects

4.4.3.1Association between Maize Income and Students' Transition

The pairwise Spearman's rank correlation coefficient between mean annual maize income (Table 9) and student transition (Table 11). The correlation results are presented in Table 14.

Table 14: Pairwise Spearman's rank correlation coefficients between maize income and school transition in eight forest blocks for years 2015 to 2019 in Lembus forest ecosystem

Spearman's rho		School transition 2015	School transition 2016	School transition 2017	School transition 2018	School transition 2019
Mean maize income for 2015	Correlation Coefficient	.060	.060	.060	.060	.060
	Sig. (2-tailed)	.887	.887	.887	.887	.887
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.171	.171	.171	.171	.171
	Sig. (2-tailed)	.686	.686	.686	.686	.686
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.216	.216	.216	.216	.216
	Sig. (2-tailed)	.608	.608	.608	.608	.608
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.146	.146	.146	.146	.146
	Sig. (2-tailed)	.729	.729	.729	.729	.729
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.464	.464	.464	.464	.464
	Sig. (2-tailed)	.247	.247	.247	.247	.247
	N	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

The results (Table 14) reveal that the correlation between mean maize income and school transition for the years 2015 to 2019 is not strong and statistically significant across the board. The correlation coefficients (*p*) are as low as 0.060 to moderate (0.464) with no values attaining the 0.05 or 0.01 statistical significance level, and p-values are always above 0.24 with most of them exceeding 0.887 (2015). This indicates that the changes in maize income over the course of the study did not play out or affect the school transition outcomes in a meaningful and consistent way. Although the coefficient is slightly greater in 2019 ($p = 0.464$), the fact that this coefficient is not statistically significant suggests that the results might be attributed to a chance effect, and not to a systematic effect. In general, the concluding research points to the fact that the income of maize in this project did not emerge as a powerful predictor of school transition from primary to secondary, which creates the probability of other socioeconomic or institutional factors being more decisive in terms of determining educational outcomes at the time considered. According to

Cohen's guideline (1992), the effect size varies from small (p = .060) to medium (p =0.464). Hence, there was small to medium contribution of income of maize to school transition.

The lack of a significant influence indicated that while initiatives like PELIS might contribute to household income, they might not directly influence educational transitions of students. This underscored the importance of adopting a more integrated and multi sectoral approach when designing interventions aimed at enhancing school transitions, particularly in forest adjacent communities. Most parents supply schools with bags of maize that was later used for fees. Most suppliers of maize to schools in most cases were parents.

To achieve sustainable yield output within PELIS, Matiku *et al*., (2013) in a study in Taita Hills found out that PELIS should be diversified to produce more products that meet public demand. He stressed the need to embrace PFM principles as a measure to boost production. The study found out the potential of PFM in addressing household challenges when user rights were fully exploited.

4.4.3.2 Association between Maize Income and Construction of Commercial Buildings and Boreholes

The pairwise Spearman's rank correlation coefficients were calculated between mean annual maize income (Table 9) and number of commercial buildings and boreholes constructed (Table 12). The correlation results are presented in Table 15 below.

Table 15: Spearman Rank correlation coefficients p between mean annual maize income and number of commercial buildings and boreholes constructed for the years 2015 to 2019

Spearman's rho		Commercial buildings& Boreholes 2015	Commercial buildings Boreholes 2016	Commercial &buildings& Boreholes 2017	Commercial buildings& Boreholes 2018	Commercial buildings& Boreholes 2019
Mean maize income for 2015	Correlation Coefficient	.060	.060	.060	.060	.060
	Sig. (2-tailed)	.887	.887	.887	.887	.887
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.171	.171	.171	.171	.171
	Sig. (2-tailed)	.686	.686	.686	.686	.686
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.216	.216	.216	.216	.216
	Sig. (2-tailed)	.608	.608	.608	.608	.608
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.146	.146	.146	.146	.146
	Sig. (2-tailed)	.729	.729	.729	.729	.729
	N	8	8	8	8	8
Mean maize income for 2016	Correlation Coefficient	.464	.464	.464	.464	.464
	Sig. (2-tailed)	.247	.247	.247	.247	.247
	N	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The results (Table 15) indicate that the association between mean maize income and investments made in livelihood assets including commercial buildings, apartments, and boreholes between the periods of 2015 to 2019 is weak and statistically insignificant. The correlation coefficients (*p*) are as low as 0.060 and moderate (0.464), though none has a statistically significant value at the 0.05 or 0.01, where the p-values are consistently above 0.24 and, in most cases, significantly higher (e.g., p = 0.887 in 2015). This trend implies that changes in maize income that occurred over the research period did not result in adjustable or predictable enhanced investments in physical livelihood assets at the household and community levels. Although this slightly higher coefficient in the later years ($p = 0.464$) suggests that there is a small positive correlation, the fact that the coefficient is not statistically significant shows that this correlation may not be caused by any systematic effect but by chance only. Comprehensively, the results suggest that the role of maize income as a predictor of capital investments in commercial infrastructure or water access facilities was not very strong, and other economic, institutional, or policy factors

probably had a more compelling effect on livelihood diversification. According to Cohen's guideline (1992), the effect size varies from small (p = .060) to medium (p =0.464). Hence, there was small to medium contribution of income of maize to construction of commercial buildings and boreholes. The results confirms the anticipated gains of PFM, which aimed at increased forest cover and livelihood improvement. The increment in development projects was attributed to income from maize and beans. GoK (2016) reported an increment in construction industry in Baringo County, especially around Eldama Ravin. According to National Environmental Management Authority (NEMA), commercial and business enterprises accounted for 70% of development projects in Koibatek Sub County.

4.4.3.3 Association between Beans Income and Students Transition

The pairwise Spearman's rank correlation coefficients were measured between mean annual beans income (Table 10) and student transition (Table 11) for the years 2015 to 2019. The correlation results are presented in Table 16.

Table 16: Pairwise Spearman's rank correlation coefficients between beans income and school transition

Spearman's rho		School transition 2015	School fortransition 2016	School fortransition 2017	School fortransition 2018	School fortransition for 2019
Mean Beans Income for 2015	Correlation Coefficient	-.190	-.190	-.190	-.190	-.190
	Sig. (2-tailed)	.651	.651	.651	.651	.651
	N	8	8	8	8	8
Mean Beans Income for 2016	Correlation Coefficient	-.238	-.238	-.238	-.238	-.238
	Sig. (2-tailed)	.570	.570	.570	.570	.570
	N	8	8	8	8	8
Mean Beans Income for 2017	Correlation Coefficient	.238	.238	.238	.238	.238
	Sig. (2-tailed)	.570	.570	.570	.570	.570
	N	8	8	8	8	8
Mean Beans Income for 2018	Correlation Coefficient	-.119	-.119	-.119	-.119	-.119
	Sig. (2-tailed)	.779	.779	.779	.779	.779
	N	8	8	8	8	8
Mean Beans Income for 2019	Correlation Coefficient	.143	.143	.143	.143	.143
	Sig. (2-tailed)	.736	.736	.736	.736	.736
	N	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

In Table 16, the results indicate that the association between the income of beans and the rate of school transition between 2015 and 2019 was weak, inconsistent, and statistically non-significant. The correlation coefficients (p) are scattered with small negative values (p = - 0.190 in 2015 and p = - 0.238 in 2016) as well as with weak positive ones (p = 0.238 in 2017 and p = 0.143 in 2019), however, none of the associations is statistically significant, and the p-values are always significantly greater than 0.05. In general, the results suggest that the income derived using beans was not an important determinant of school transition in the livelihood project, which implies that the other socioeconomic, household, or institutional factors might have been more decisive in determining educational progression at the period under consideration. According to Cohen's guideline (1992), the effect size was small (p =0.143) and (p =0.238). Hence, there was small contribution of income of beans to school transition.

In concurrence, Gobeze *et al.,* (2009), reported a significant improvement in education sector through firewood collection and grazing inside the forest. These activities were later operationalised to address diverse household aspects like school fees and commercial ventures. (Panel. A and Mulunch, G, (2024) found the significant impact of PFM on poverty reduction within households including facilitating educational requirements of children.

4.4.3.4 Association between Beans Income and Commercial Buildings and Boreholes

The Spearman's rank correlation coefficients were calculated between mean annual beans income (Table 10) and commercial buldings and boreholes (Table 12). The correlation results are presented in Table 17.

Table 17: Spearman's rank correlation between beans income and commercial buildings and boreholes

Spearman's rho		Commercial buildings& Boreholes for 2015	Commercial buildings& Boreholes for 2016	Commercial buildings& Boreholes for 2017	Commercial buildings& Boreholes for 2018	Commercial buildings& Boreholes for 2019
Mean Beans Income for 2015	Correlation Coefficient	-.190	-.190	-.190	-.190	-.190
	Sig. (2-tailed)	.651	.651	.651	.651	.651
	N	8	8	8	8	8
Mean Beans Income for 2016	Correlation Coefficient	-.238	-.238	-.238	-.238	-.238
	Sig. (2-tailed)	.570	.570	.570	.570	.570
	N	8	8	8	8	8
Mean Beans Income for 2017	Correlation Coefficient	.238	.238	.238	.238	.238
	Sig. (2-tailed)	.570	.570	.570	.570	.570
	N	8	8	8	8	8
Mean Beans Income for 2018	Correlation Coefficient	-.119	-.119	-.119	-.119	-.119
	Sig. (2-tailed)	.779	.779	.779	.779	.779
	N	8	8	8	8	8
Mean Beans Income for 2019	Correlation Coefficient	.143	.143	.143	.143	.143
	Sig. (2-tailed)	.736	.736	.736	.736	.736
	N	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The results in Table 17 indicate that the relationship between beans income and investments in livelihood assets such as commercial buildings, apartments, and boreholes from 2015 to 2019 is weak, inconsistent, and statistically insignificant. The correlation coefficients (ρ) fluctuate between small negative values (p = – 0.190 in 2015 and p = – 0.238 in 2016) and small positive values (p = 0.238 in 2017 and p = 0.143 in 2019), but none of these associations reach statistical significance, with p-values consistently well above 0.05 (ranging from 0.570 to 0.779). This pattern suggests that variations in beans income during the study period did not systematically influence household or community-level investments in physical livelihood assets. Overall, the findings suggest that beans income was not a meaningful driver of capital investments in commercial or infrastructural assets within the livelihood project, pointing to the possibility that other income sources or structural factors played a more decisive role in shaping such investments. According to Cohen's guideline (1992), the effect size was small (p =0.143, and

p=0.238. Hence, there was small contribution of income from beans to construction of commercial buildings and boreholes. The finding supports Josephine *et al.,* (2024)who recommended that the proceeds from PFM initiatives had a significant impact on rural livelihood.

4.4.3.5Association between Income from Medicinal Herbs and Students Transition

The pairwise Spearman's rank correlation coefficients were calculated to measure the association between income from medicinal herbs (Table 13) and student transition (Table 11). The correlation results are presented in Table 18.

Table 18: Spearman's rank correlation between income from herbs (medicine) among the CFAs (Kshs) and school transition

Spearman's rho		**School transition for 2015**	**School transition for 2016**	**School transition for 2017**	**School transition for 2018**	**School transition for 2019**
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2015	Correlation Coefficient	.000	.000	.000	.000	.000
	Sig. (2-tailed)	1.000	1.000	1.000	1.000	1.000
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2016	Correlation Coefficient	.036	.036	.036	.036	.036
	Sig. (2-tailed)	.933	.933	.933	.933	.933
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2017	Correlation Coefficient	-.036	-.036	-.036	-.036	-.036
	Sig. (2-tailed)	.933	.933	.933	.933	.933
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2018	Correlation Coefficient	.265	.265	.265	.265	.265
	Sig. (2-tailed)	.526	.526	.526	.526	.526
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2019	Correlation Coefficient	.048	.048	.048	.048	.048
	Sig. (2-tailed)	.910	.910	.910	.910	.910
	N	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 18 indicates that the income of herbs (medicine) among CFAs did not have any significant correlation with the school transition during 2015 and 2019. The correlation coefficients between them were very weak (p= -0.036 to 0.265) and had no statistical significance (p > 0.05). It means that herbal income changes did not affect educational progression, and there were other socioeconomic variables that were more conclusive in the determination of school transition outcomes.

According to Cohen's guideline (1992), the effect size was small (p =0.036, and p =0.265. However, there was small contribution of income from medicinal herbs to school transition as confirmed by Ongugo, *et al*.,(2015)that some of the economic impacts of PFM (medicinal value) had the potential to improve livelihood. Treue, *et al., (*2014) also emphasised that the impacts PFM has a direct influence community livelihood and depended on how the existing natural resources were managed. FAO, (2015) reported on the need on the gender engagements in the PFM initiatives to boost production, however 30% of men were actively involved in forest farming and this explained why fuel wood production had a significant influence on the school transition.

4.4.3.6 Association between Income from Medicinal Herbs and Commercial Buildings and Boreholes

The pairwise Searman's rank correlation coefficients were calculated to measure the association between income from medicinal herbs (Table 13) and commercial buildings and boreholes (Table 12). The correlation results are presented in Table 19.

Table 19*:* Spearman Rank correlation coefficientsp between income from medicinal herbs and commercial buildings and boreholes

Spearman's rho		Commercial buildings& Boreholes for 2015	Commercial buildings& Boreholes for 2016	Commercial buildings& Boreholes for 2017	Commercial buildings& Boreholes for 2018	Commercial buildings&Boreholes for 2019
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2015	Correlation Coefficient	.000	.000	.000	.000	.000
	Sig. (2-tailed)	1.000	1.000	1.000	1.000	1.000
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2016	Correlation Coefficient	.036	.036	.036	.036	.036
	Sig. (2-tailed)	.933	.933	.933	.933	.933
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2017	Correlation Coefficient	-.036	-.036	-.036	-.036	-.036
	Sig. (2-tailed)	.933	.933	.933	.933	.933
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2018	Correlation Coefficient	.265	.265	.265	.265	.265
	Sig. (2-tailed)	.526	.526	.526	.526	.526
	N	8	8	8	8	8
Mean annual Income from herbs (medicine) among the CFAs (Kshs) for 2019	Correlation Coefficient	.048	.048	.048	.048	.048
	Sig. (2-tailed)	.910	.910	.910	.910	.910
	N	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

In Table 19, the results show that there was no significant correlation between income of herbs (medicine) among CFAs and investments in livelihood assets (commercial buildings, apartments and boreholes) in the year 2015 to 2019. The correlation coefficients are too insignificant with a long range between p = -0.036 to p = 0.265 with the p-values always exceeding 0.05 (p = 0.526-1.000) and are not statistically significant. The fact that the coefficients are negative, then positive (applied slightly negative in 2017), but reverse in other years indicates that there was no systematic trend, but the variation was random. All in all, these results suggest that herbal

revenue did not play a major role in capital investments in physical livelihood assets in the study period hence the probability of other sources of income or structural factors having a greater influence in motivating such developments.According to Cohen's guideline (1992), the effect size was small (p =0.036, and p =0.265. Hence, there was small contribution of income from medicinal herbs to construction of commercial buildings and boreholes. According to FAO, (2008), most rural households largely depend on PFM to undertake major development projects within their areas. Ghate (2010), further confirmed that the community participation in the PFM had direct impact on their livelihood, including social amenities like housing and business enterprises.

4.5 Costs and Benefits Analysis in Plantation Establishment and Livelihood Improvement Scheme in Lembus Forest Ecosystem

The value of two forests products from PELIS in Lembus forest ecosystem were estimated in Kenya Shillings. The forest products include medicinal herbs and fuelwood; the data is presented in Table 20.

Table 20: Estimated value of Benefits from PELIS in Kenya Shillings (Kshs) for the years 2015 to 2019

Item	2015	2016	2017	2018	2019
PELIS	1,098,717.00	1,417,211.00	1,683,993.00	1,874,496.00	3,497,270.00
Herbal medicines	83,050.00	89,728.00	110,180.00	97,580.00	259,890.00
Fuel wood	315,210.00	331,340.00	349,540.00	387,000.00	414,780.00
Total	1,496,977.00	1,838,279.00	1,909,433.00	2,359,076.00	3,854,740.00

Source: Researcher, 2023

The benefits from the PFM was expressed in terms of sales of maize and beans under the PELIS programme, and sales of herbal medicine and fuel wood by CFA members in Kenya shillings. The benefits from the PFM was expressed in terms of sales of maize and beans under the PELIS programme, and sales of herbal medicine and fuel wood by CFA members in Kenya Shillings. The result shows value of benefits derived from PFM by CFAs.

The costs incurred by the PFM implementing agencies was also estimated for the years 2015 to 2019. The estimation was computed in terms of costs of renting plots in forests (PELIS), raising seedlings and establishing plantations. Table 21 gives an estimate of the costs, which were generated using the Task Rates from FD (2005) and GoK labour rates.

Table 21: Estimated Costs of implementing PFM for the years 2015 to 2019

Item	2015	2016	2017	2018	2019
Cost of plantation Establishment	59,221,460	118,442,920	117,664,380	236,885,840	296,107,300
Cost of raising seedlings	129,506.40	259,012.80	388,519.20	518,025.60	647,532.00
Cost of renting plots in forest (PELIS)	166,733.30	333,466.70	500,199.90	666,933.20	833,666.50
Total	**59,517,700**	**119,035,400**	**118,553,099**	**238,070,799**	**297,588,499**

Source: KFS, 2019 * ***the figures in table 38 above was generated using the Task Rates from FD (2005) and GoK labour rates (Kshs. 419.00).***

An examination of the data show that there was a major increment in cost in 2016 compared to the previous year. A slight decline in cost was recorded in the year 2017; this was followed with a steady increment in costs in the years 2018, and 2019. A cost and benefits analysis of participatory plantation establishment and livelihood scheme in Lembus forest was conducted after estimating the costs of implementing PFM and benefits associated with it. The analysis involved calculating the cost and benefits means for the years 2015 to 2019 and comparing them using the independent sample t-test. The results of the test are presented in Table 22.

Table 22: T-Test results comparing Estimated Cost and Benefits of PFM

Estimate	N	Mean	SD	Df	p-value	p-value
Benefit	15	685590.20	859745.35	28	2.213	.035
Cost	15	55517699.71	95970409.87			

The results in Table 22 show that the mean cost (M = Kshs. 55517699.71, SD = 95970409.87) of PFM was higher the benefits mean (M = Kshs. 685590.20, SD = 859745.35). The results further show that the difference between the two means was statistically significant, t (28) = 2.213,

p<.05. The result therefore confirms that the cost of implementing PFM is more than the benefits associated with it. According to Kagombe, (2014) in a study carried out in Gathiuru, Kamae and Thogoto, it was found out that PELIS had economic benefits to both forest authorities and CFAs, where the former benefitted from low costs of plantation establishment with high seedlings survival and the latter getting livelihood benefits. However, the actual benefit the Forest authorities get from such advantages seem to be higher than those of CFAs. The result, therefore, confirmed fears of imbalance in consumption of forest resources in favour of Forest authorities (Kallert *et al.* 2000 and Thenya *et al*., 2007). Similar fears had also been expressed in Uganda and India on skewed consumption of forest resources in favour of the Authorities, citing lack of shareable formula (Saxena, 1998).

Equitable consumption of forests resources was a key thematic area that formed the basis of the Forest Act, 2005. Issues of imbalance and skewed utilization in favour of the Forest Authorities continue to gain prominence among forest adjacent communities, county governments and natural resource economists, especially management of PELIS. In this chapter, analysis was focused on current utilization trend between the CFAs and the Forests authorities with specific emphasis on PELIS. In the study, area over 80% of the respondents gave PELIS a high approval rating in improvement of their livelihood. This appeared to be a sharp departure from the provisions of the previous law (Cap, 385 Laws of Kenya) that completely prohibited any economic activity to be carried out within a gazetted forest area. It was then illegal to carry out any economic activity within the gazetted forest area, farming included. Figure 4 below presents the approval rate.

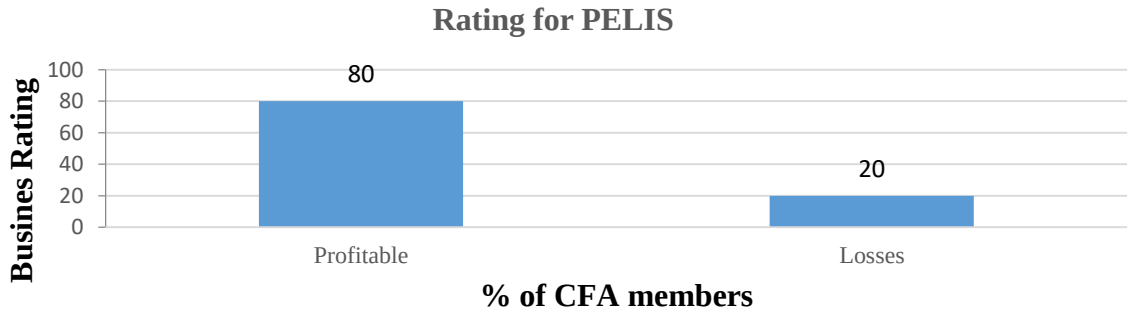


Figure 4: Approval rating for PELIS

Before the operationalization of the current Forest Act, PELIS existed but in a different name called *Shamba system*. Shamba system also received high approval rating though it faced many difficulties when the PFM had not been put in place. Figure 5 below shows the approval rating of the Shamba System before PFM was operationalised.

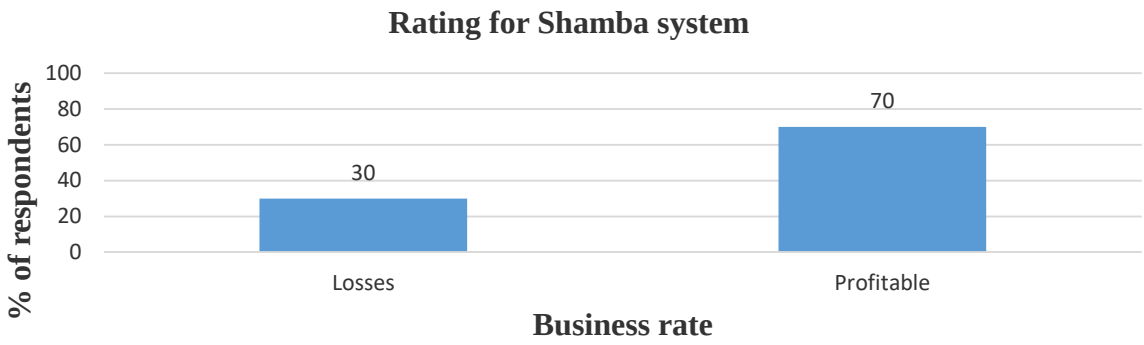


Figure 5: Approval rating for Shamba System

4.5.1 Allocation of Glades for PELIS

The Lembus forests complex accounts for over 30% indigenous forest cover, while plantation establishment is 70%. Most PELIS activities are centered on plantation areas that is subject to application of silvicultural operations including spacing, thinning and pruning at a later stage, depending on the applicable Technical Orders. There was high restriction within natural forests in fear to disturbance of the ecosystem, which formed a habitat for wildlife and even water sources. However, the respondents gave high approval rating to fair allocation of plots to be planted by the Forest authorities. The original anticipation was high demand for few available areas to be allocated and lack of transparency in the allocation. In assessment of fair allocation of the plots to be allocated, the respondents had highly approved fairness for rating as shown in figure 6.

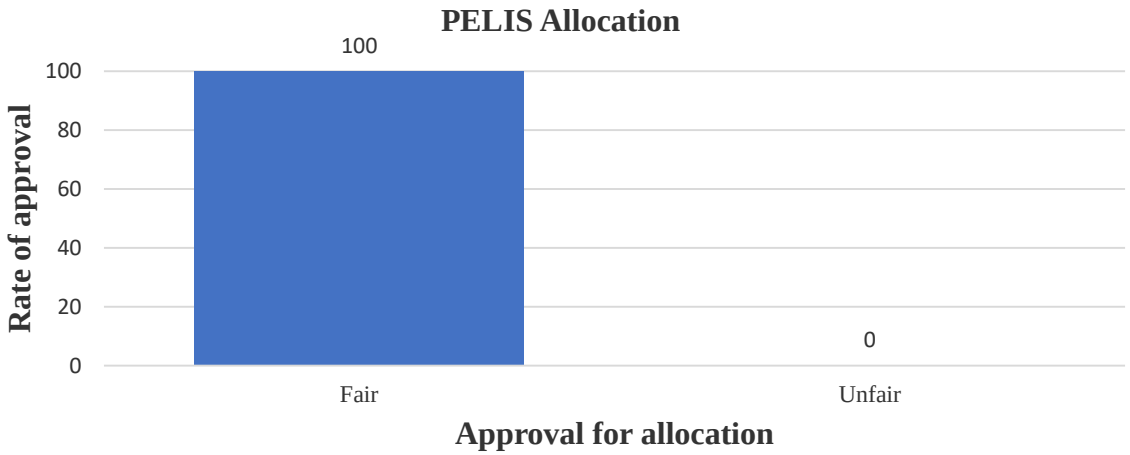


Figure 6: Approval for PELIS allocation in the forests

4.5.2 Production Input

In verification of other external input applied in crop production, varied results were obtained concerning fertilizer application. Most forestland contained necessary soil nutrient's that support crop production. However, about 20% of the respondents recorded moderate application while 30 % have low application. There was enormous approval of high production without application of fertilizer. The figure below shows the number of CFA members applying fertilizers within the farms.

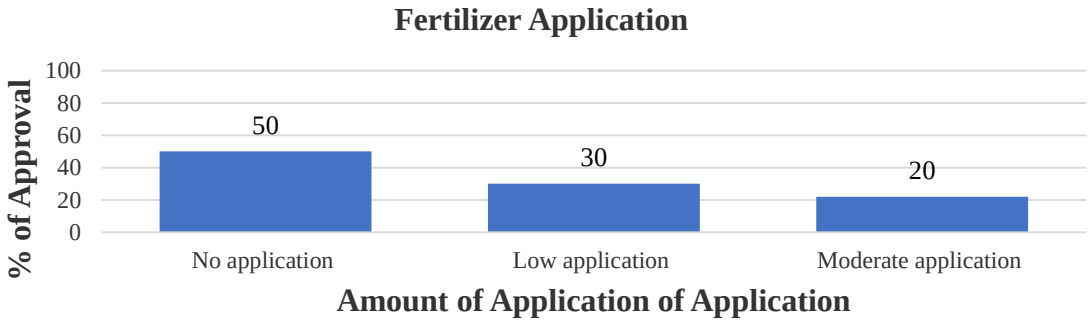


Figure 7: Rate of fertilizer application

When assessing the potential of PELIS in production status since the Act was operationalised, there was a general trend showing limited application of farm input like fertilizers to enhance production under PELIS. All respondents appreciated high production trend without farm

treatments. This meant there was minimal farm treatment to ensure crop production hence showing profitability.

Saw milling industry was a critical sector when determining its distribution of forests resources among various players. One major source of revenue to the Government was through forest logging. As stake holders in the industry through PFM, CFA views were collected on how the tenders for saw millers were advertised and awarded. This was done to assess the inclusion of the local CFA in the industry. About 93% of the respondents said the award of logging operations is done in a skewed way. Given that none of them sits in the National tender committee, they had lots of reservations in fair distribution of tenders, most of them insisting that most saw millers were single sources from outside the county.

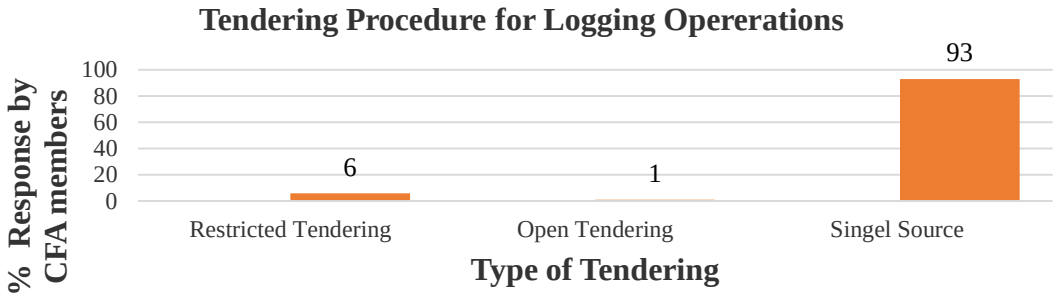


Figure 8: Tendering procedure for forest logging

Given that forest logging contributes a lot of money to the Government through the forest's authorities, the CFA members anticipate that a share of such proceeds should be retained or wired back to the county to address some community challenges and livelihoods projects. According to the respondents, apart from road construction, no other projects have been supported by the forests authorities to address livelihood challenges and this poses a gap at policy and legislative levels. In other countries like Tanzania and Mozambique, the law requires that 20% of the levies on forest products are destined to support community projects, however, the formulae to be used still remained unclear, especially on the targeted beneficiaries (Thenya *et al.,* 2007).

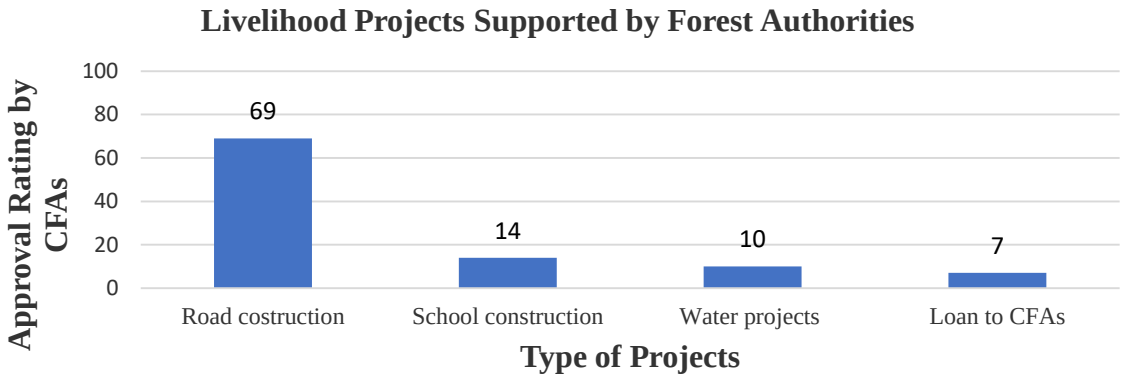


Figure 9: Livelihood Projects supported through forest proceeds by forest authorities

In Natural resource management, there are guiding principles that ensure resources are managed sustainably to equity among stakeholders in the sector. The majority of CFA members gave their views as illustrated in Figure 10 below.

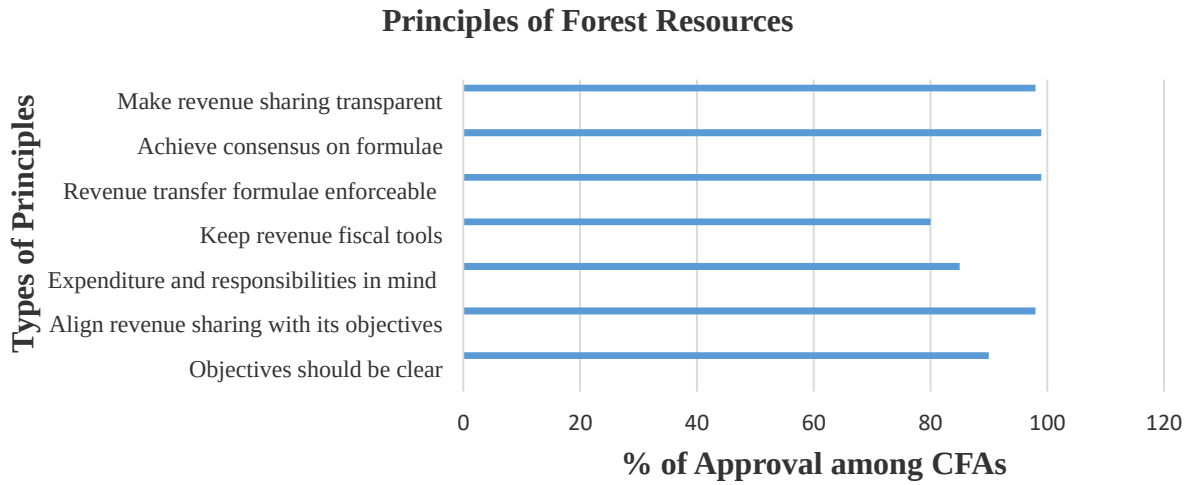


Figure 10: Principles of forest resource allocation

Disparities associated by consumption of forests resources elicited diverse proposals in order to address equity in sharing it. Some of the proposals to ensure equitable distribution are tabulated here below.

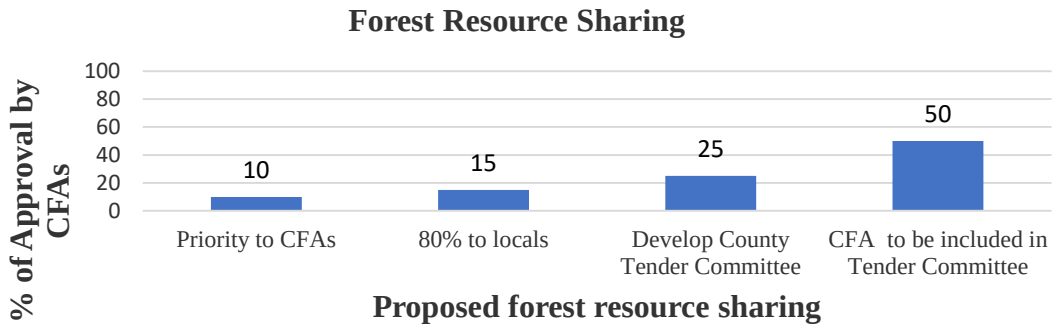


Figure 11: Proposed ways of sharing forests resources

In conclusion, PELIS as an ecological and livelihood security intervention tool has proved viable however, there was an imbalance on the consumption of PELIS proceeds between the forest authorities and CFAs. The Community Forest Association members tend to spend more that the anticipated benefits. This therefore required policy and legislative intervention to address the inequality. A regression analysis found a negative correlation between the costs and benefits.

4.6 Level of Awareness of Policy and Legislations on Forest Cover, Livelihood and Equity

4.6.1 Analysis of Forest Cover Legislations

4.6.1.1 The Forests Act, 2005

The respondents were interviewed concerning their level of awareness of Forests Act 2025 and related amendments and the results are presented in Table 23.

Table 23: Level of Awareness on Forest Act, 2005 and related Amendments

Legislations	Average Level of awareness (%)
	Aware
Part VI, section 53 of the Act on ***Incentive for increasing forest and tree cover***	5
Part VI, section 54 provides for ***Tax and fiscal incentives***	2
Section 27 of Forest Act (Amendment), 2016 provides ***for Forest Management and Conservation Fund***	5
Part VI, section 55 provides for the ***Tree Planting Week***	30
Section 32 of Forest Act (Amendment), 2016 with the provision of the management ***of community forests****.*	10
The forest Act, 2005, Section 40 Subsection (!) ***provides for the concession by the KFS****.*	15

*Section 27 of Forest Act (Amendment), 2016 provides **for Forest Management and Conservation Fund,** which was meant for the development of forests among other functions.*	10
The forest Act, 2005 on Community capacity building on how rights can be enhanced on joint forests management	20

Source: Researcher, 2019

Lack of awaress on the existing legislations was the main cause of continued loss of forest cover in the country. About 80% of the respondents were not aware that existed important provisions in the Forest Act, 2005 that could easily facilitate transition to 10% forest cover. More importantly, the Forest Act, 2005 further provided for community capacity building on how rights could be enhanced on joint forests management. This is function of the Forest authorities.The CFAs should be knowledgeable on tree nursery establishments, entrepreneurial skills and other livelihood-based project management. However, the results indicate only 20% of them were aware of such initiatives and this might compromise their ability to protect the trees. Other important provisions that were not widely known included the establishment and management of community forests, the Concession of forest and the Forest Management and Conservation Fund at 10%, 15% and 10% respectively. The rating on these critical provisions of the Forest Act, 2005 was a function of lack of awareness and knowledge.Tree Planting Week was widely known by most Kenyans. During FGD, about 30% of the partcipants were aware of it.This partly explains why the tree cover in Kenya has reached 10%.

Lack of awareness in critical provisions of the Forest Act was a function of inadequate public participation. In Kenya, public participation gained more prominence if the legislation in question is political, like the Constitution of Kenya, 2010, the Building Bridges initiatives (BBI), 2021. In concurrence with the findings, the UN (2011) cited lack of lack of proper regulations, late notifications and procedure as factors hindering public participation in environmental laws in Africa. Tree Planting Week had the highest rating at 30% because it was celebrated annually, with executive orders from the Presidency. This created more awareness than any other provision in the Act.

4.6.1.2 Environment Management and Coordination Act (EMCA, 1999)

The respondents were interviewed concerning their level of awareness of EMCA1999 and related amendments and the results are presented in Table 24.

Table 24: Level of Awareness on EMCA, 1999 and related Amendments

Legislations	Average Level of awareness (%)
	Aware
Section 9(2) (r) of the *Act that requires NEMA to develop guidelines for achievement of a 10% tree cover. This a joint initiative between NEMA and other key lead institutions*	5
NEMA to *develop Regulations and Guidelines for the management of Hiltops, Hillsides and Wetlands. The management strategies to include reafforestion and afforestation.*	2
Commemoration of World Environment Days (WED, Wetlands Day, Desertification Day, Cleanup Day)	40

Source: ***Researcher, 2019***

During FGDs, there was inadequate awareness of the first two provisions with a 5% and 2% level of knowledge. On the World Environment Days, the media played a crucial role by a 40% of the general populace approval. For example in EMCA 1999, a guideline had not been done in order to operationalise this provision to provide a platform to an intervention on the degradation of hillsides and hilltops. The law also mandated NEMAto work closely with other institutions and entities to develop guidelines and regulations to facilitate tree planting in hillsides, hilltops and wetlands.

In this respect, only wetland regulations had been done by NEMA to operationalise this provision. However, no regulations had been made for sustainable management of hilltops and hillsides, making it difficult to affect the provisions to ensure tree cover improvement. This therefore called for NEMA to speed up the process of operationalising Section 9(2) (r) and Section 44.

4.6.1.3 Agriculture (Farm Forestry) Rules, 2009

The respondents were interviewed concerning their level of awareness of Agriculture rules 2009 and related amendments and the results are presented in Table 25.

Table 25: Level of Awareness on Agriculture (Farm Forestry) Rules 2009

Legislations	Average Level of awareness (%)
	Aware
Maintenance of tree cover at 10% within the farming land for the purposes of environmental sustainability, climate change and global warming,	35

Source: Researcher, 2019

Increased participation in farm forestry at 35% was partially attributed to its contribution of about 75% of the GDP of the country. Secondly, the agriculture functions were devolved into county governments under the 2010 new constitution, hence opening wider public participation, under the stewardship of the county governments. However, about 65% of the partcipants were not aware of its critical role in maintaining the tree cover to 10%. A knowleageable 65% of the population could easily facilitate the increased tree cover in the country.

4.6.1.4 The Constitution of Kenya, 2010

The constitution, according to the results was the only legal document with a wider knowledge among the citizenry at 50%. Table 26 shows the level of awareness among CFAs in the study area. High level of awareness was attributed to a lot of political involvement in process.

Table 26: Level of Awareness on the Constitution of Kenya, 2010

Legislations	Average Level of awareness (%)
	Aware
Attainment of a UN tree cover threshold of 10% in Kenya.	50

Source: Researcher, 2019

Active participation of Citizenry into tree planting under the constitution was a function of involvement of the political class, non-state actors and the civil society under multiple donor support. Further, the constitution of Kenya had an edge over other legislations due massive resource involvement in public participation. A 50% rating of the Constitution was further supported by civil society and other non-state actors with multiple donor support, and mobilized the opposition and their supporters thus creating a popular movement. However, the remaining 50% of the partcipants would play a very important role in securing a 10% tree cover transition. Other forms of communications could be brought on board to create awareness to the public.

4.6.1.5 The Kenya Vision 2030

Environment formed one of the key pillars of the Vision 2030. It emphasized the need to attainment of a 10% tree cover threshold as recommended internationally. Table 27 shows the level of awareness of respondents.

Table 27: Level of Awareness on the Kenya Vision 2030

Legislations	**Average Level of awareness (%)**
	Aware
It envisages a 10% forest cover by 2030 and sustainable utilization and management of its resources for the present and future economic growth	15

Source: Researcher, 2019

Vision 2030 also aligned its mandate to the forests sector with an advocation on sustainable utilization and management of its resources for the present and future economic growth. It had the potential to considerably increase tree cover if public participation was effectively done. However, limited number of the area residents were aware of such legal provision i.e. 15% approval with 85% citing lack of public participations as the reason limiting access to public information.

4.6.1.6 The Medium-Term Plan III (2018-2022)

The document is a sure way of effecting tree cover in the country. Table 28 shows the summary of level of awareness.

Table 28: Level of Awareness on the Medium-Term Plan III (2018-2022)

Legislations	Average Level of awareness (%)
	Aware
Government's commitment to protection of Indigenous forests ecosystems in the ecologically sensitive water areas to ensure sustained water supply.	10

Source: Researcher: 2019

However, during the FGDs, on public opinion, only 10% are aware of its existence, while 90% of the respondents attributed lack of knowledge to inadequate public participation and the Government for failure to sensitize the citizenry on most important development Blue Prints being implemented by the Government. According to UN, (2011) some impediments relating to public participation in decision-making policies like Medium-Term Plan III (2018-2022 still lack clarity on implementation.

4.6.1.7 The Forests and the Big 4 Agenda

The Table 29 shows the rate of awareness of the Big 4 Agenda among the local population.

Table 29: Level of Awareness on the Forests and the Big 4 Agenda

Legislations	Average Level of awareness (%)
	Aware
To protect forests and its resources for sustained provision of ecosystem services for to spur economic growth.	5

Source: Researcher, 2019

This agenda was only known 5% of the respondents, while the remaining 95% never knew it had an environmental component. The discussion looked at its potential in addressing the tree cover deficit currently experienced in the country. The majority attributed to lack of knowledge to inadequate public participation. More communication dissemination platform needed to be put in place to ensure wider coverage among the population.

4.6.1.8 International Conventions and Obligations

Table 30 shows the average level of awareness to International Conventions and obligations.

Table 30: Level of Awareness on International conventions and obligations

Legislations	Average Level of awareness (%)
	Aware
Government is committed to effect compliance to global and Multilateral Environmental Agreements demands with large investments in rehabilitation of degraded ecosystems with massive tree planting as a strategy	2

Source: Researcher, 2019

These Conventions were considered able to translate into tree / forests cover during FDGs; however, there was limited information of their existence among the rural folk. Only 2% were knowledgeable of its existence while 98 % attribute lack of knowledge to the Government and media industry. The group resolved that the Government needed to initiate a process that allows the public access vital environmental information at grass root level. Capacity building to be done to local leaders in order to disseminate the knowledge to the local population.

4.6.1.9 The Wildlife Policy, 2011

The respondents were also interviewed on their level of awareness to wildlife policy 2011 (Table 31)

Table 31: Level of Awareness on the Wildlife Policy, 2011

Legislations	Average Level of awareness (%)
	Aware

Provides for animals find settlement under trees. Animals too feed on some trees. and it's the responsibility of the Authorities, Communities to protect exiting vegetation and tree for the benefit of the wildlife	5

Source: Researcher, 2019

During the FGDs, only 5% of the participants were aware of this provision and 95% of them attributed lack of knowledge to absence of a National park or a Game reserve in the study area. The Wildlife Authorities in Kenya also had an important role to play to address tree cover challenges in the country. Trees offer habitat and act as feed to the Wildlife. Trees planting within the National or Game parks could significantly contribute to the general tree cover improvement in the country.

4.6.1.10 Sessional Paper No. 3 of 2009 on National Land Policy

The repondents were interviewed on their level of awareness on National Land policy and National Land use policy (Tables 32 & 33).

Table 32: Level of Awareness on Sessional Paper No. 3 of 2009 on National Land Policy

Legislations	**Average Level of awareness (%)**
	Aware
Environmental management principles geared towards restoration of degraded ecosystems. *It further advocates for restoration of degraded landscapes.*	5

Source: Researcher, 2019

This policy framework becomes one of the strategies to intervene in land degradation and therefore provides an opportunity for tree planting as intervention for most fragile ecological systems. During the group discussion, only 5% of the participants were aware of it, while the remaining 95% decry lack of knowledge to the relevant government entity with responsibility of managing land resources.

4.6.1.11The Sessional Paper No. 1 of 2017 on National Land Use Policy

Table 33: Level of Awareness on National Land Use Policy

Legislations	Average Level of awareness (%)
	Aware
Provision of a framework land use and related resources. *Water Resource Conservation and reduction of climate change effects for continuous of water supply to support livelihood needs*	8

Source: Researcher, 2019

The level of awareness rated as low as 8%, while a staggering 92% rate disapproval. This was also attributed to lack of public participation and awareness creation. Trees act as the source of rivers in the country. When there was sufficient tree cover, there would be sustained water provision and climate change security. Capacity building was supposed to be done to the 92% the partcipants so that the potential of *The Sessional Paper No. 1 of 2017 on National Land Use Policy* could be realized.

4.6.1.12 National Policy for Disaster Management

This is a policy that should be implemented by all relevant Government agencies, community members among other stakeholders. The low level of awareness (Table 34) was a function of inadequate public participation. Trees act as buffer to strong winds with a potential to cause disasters.

Table 34: Level of Awareness on National Land Use Policy (NLUP)

Legislations	Average Level of awareness (%)
	Aware

The policy stresses the need for all stakeholders to be on alert in a disaster anticipation, preferably by planting tree in disaster prone areas	12

Source: Researcher, 2019

Trees too has the capacity to hold the soil together to reduce landslides and erosion occasioned by rapid surface run off. An informed 88% of the participants were not aware of the policy could significantly improve the tree cover in the country.

4.6.1.13The National Water Policy of Kenya, 1999

Table 35: Level of Awareness on the National Water Policy of Kenya 1999

Legislations	**Average Level of awareness (%)**
	Aware
Aims to achieve sustainable development and management of the water sector by providing mitigation measures that reduce degradation of water resources like tree planting in catchments.	2

Source: Researcher, 2019

Most water sources were within the Kenya Water towers (the Mau, Aberdare, Mt. Kenya forests) and protected by vegetation, which called for Government agencies to like the KFS, Kenya Water Towers to protect, maintain and plant the existing forests. The local CFAs could play a critical role in fulfilling this policy. However, Lembus ecosystem, being part of the Mau forests, the participants had little information on the policy to enable them spearhead massive tree planting exercise as shown in the table below. GoK,(2020) estimated the fiscal value of the Mau forests complex to Kshs. 110 Billion annually, while Aberdare stood at Kshs. 51 Billion annually.

4.6.1.14 The National Biodiversity Strategy of 2000

Table 36: Level of Awareness on the National Biodiversity Strategy of 2000

Legislations	**Average level of awareness**

	(%)
	Aware
A National framework of action for Biodiversity sustainability.	5

Source: Researcher, 2019

Biodiversity conservation is a combination of plants and animals. The stategy offers a better platform to advance the tree planting agenda as part of landscape restoration process. During the FGD, only 5% of the group were aware of the existing strategy. An informed 95% of the partcipants had the potential to influence tree planting not only to address the biodiversity sustainability, but the tree cover improvement in the county.

4.6.1.15 Summary of Policy and Legislative Strengths on Tree Cover in Lembus Ecosystem

Table 37: Analysis of Awareness of various legislations on forest / tree cover

Legislations	Average level of awareness (%)
Forests Act, 2005	12.2 %
EMCA, 1999	15.6%
Agriculture (Farm Forestry) Rules 2009	35%
The Constitution of Kenya	50%
The Kenya Vision 2030 on Forests cover	15%
Medium Term Plan III (2018-2022)	10%
Forests and the Big 4 agenda	5 %

Source: Researcher, 2019

In the process of conducting Focus Group Discussion, varied reasons were attributed to lack of knowledge on environmental legislations, especially those pro- tree planting, both on gazetted forests and on farm or private lands. On analysis of the response, the Constitution of Kenya, 2010 was the main document with wide accelerated knowledge with 50% awareness level. This was attributed to vast public participation that was mounted before its promulgation. In the discussion, it was observed that legislations with heavy political implications had much public awareness than others. The Building Bridges Initiative (BBI), for example had wider coverage within a shorter time. Agriculture (Farm Forestry) Rules 2009 was rated second because the function had been devolved to the counties, hence more citizens were aware of it, especially in its role to address food security at the rural level. The third was Environment Management and

Coordination Act, 1999, whose key role incuded spearheading the World Environment Day celebrations, which is an international event.

4.6.2 Legislations that Influence Livelihood in Forested Ecosystems

During the Focus Group Discussion with CFAs, a number of legislations were identified to support livelihood through tree planting. It was observed that there were several provisions in environmental laws that cut across all the three aspects of the study i.e. tree cover increment, livelihood improvement and equity.

4.6.2.1 The Forest Act, 2005

The Table below presents rate of approval of various provisions of the Act.

Table 38: Level of Awareness on Forest Act, 2005 and related Amendments on livelihood

Legislations	**Average Level of awareness (%)**
	Aware
In the Forest Act, 2005 Community capacity building on how rights can be enhanced on joint forests management	5
In section 47(2) of the Forest Act, 2005 gives opportunity to CFAs to carryout activities in the forest that primarily address their livelihood.	80
Part VI, Section 53 of the Forest Act, advocates for the benefit sharing between the public and investors in the forest sector (infrastructure)	10
The Forest Conservation and Management Act, 2016, which provides PFM advocates for technical training for community-based forest.	60
Section 6(3)(a)(iii) of Forest Conservation and Management Act (Amendment), 2016 highlights the need to develop programmes for achievement and maintenance of tree cover of at least 10%of the land area of Kenya	10
Part VII Section 56 of the Forests Act, (Amendment,) 2016 on private sector involvement in forest management.	15

Source: Resaercher, 2019

In section 47(2) of the Forest Act, 2005 gives opportunity to CFAs to carryout activities in the forest that primarily address their livelihood. It gives the CFA opportunity to enter *into*

agreement with the Forestry Director to consume the agreed user rights, which include among others plantations establishment through nonresidential (PELIS). This section had the highest approval (80%) because it was the one that paved way for PELIS among other user rights.

4.6.2.2 The Natural resource (Benefit sharing) Bill, 2018

Table 39: Level of Awareness on the Natural resource (benefit sharing) Bill, 2018 on livelihood

Legislations	Average Level of awareness (%)
	Aware
Every affected organization shall work closely with relevant County to develop a mutual agreement on benefit sharing	5
Section 27(2) further provides for a county based committee that runs the benefit sharing issues	2

Source: Researcher, 2019

The Bill has a direct influence on community livelihood on consumption of forests resources. It provided for the creation of a benefit sharing entity based at the County level to oversee resource rationalization and consumption and further classifies forests as one of the Natural resources. The Bill did not only provide for equity but also improved livelihood standards of the local communities. Currently, there are a number of Natural resources in the country that required a balanced consumption between the Authorities and the local people. These include oil in Turkana, Wildlife resources, Mineral resources among others.

4.6.2.3 Environmental Management and Coordination Act (EMCA, 1999)

Table 40 below presents the rate of awareness among the CFAs.

Table 40: Level of Awareness on Environmental Management and Coordination Act, 1999 on livelihood

Legislations	Average Level of awareness (%)
	Aware
Issuance of environmental licenses for all forest-related developments	*5*
Development of guidelines and prescription of measures targeting a 10% recommended functional forest ecosystem in Kenya.	*2*
Protection of hilltops, hillsides and wetlands	*1*

Source; Researcher, 2019

Development of guidelines and prescription of measures targeting a 10% recommended functional forest ecosystem in Kenya. This provision had a direct impact on food production as maintaining a 10% forest cover triggered favorable climate. This directly translate into a boost in food production as increased hilltop, mountain forest cover too had direst bearing of climatic condition favorable to increased production.

4.6.2.4 Agriculture (Farm Forestry) Rules, 2009

Table 41 below presents the rate of awareness among CFAs in the study area.

Table 41: Level of Awareness on Agriculture (Farm Forestry) Rules 2009

Legislations	Average Level of awareness (%)
	Aware
Integration of tree and crops within a farm ensures security in food production and ecological integrity.	5

Source: Researcher, 2019

A 10% tree cover influences conducive micro climatic condition for enhanced food production for improvement of community livelihood. However, the local population still unaware of that provision to enhance food production. During the FGD, majority of the partcipants appreciated its role as an instrument to address forest cover, but not food security. A lot of capacity buiding was therefore needed among the local population on the role of the Rules in addressing food security challenges.

4.6.2.5 The Constitution of Kenya

Table 42 below presents the rate of awareness on the law and its potential on food security.

Table 42: Level of Awareness on the Constitution

Legislations	Average Level of awareness (%)
	Aware
Article 69(1) (b) attainment of a 10% forest cover is a sure measure to ensure rainfall distribution and reliability to support food production systems.	50

Source: Researcher, 2019

Increased forest cover potentially influences rainfall to support agricultural production and other related livelihood infrastructure. A country with adequate forest cover has a reliable rainfall patterns, reduces climate variability and ensures support to food productions systems. If the remaining 50% of the partcipants were made ware of this critical agricultural provision in the Constitution, then the country could be food secure within the shortest period.

4.6.2.6 International Conventions and Obligations

Table 43: Level of Awareness on International Conventions and Obligations

Legislations	Average Level of awareness (%)
	Aware
A 5.1 Landscape restoration target by the year 2030.	5

Source: Researcher, 2019

To achieve this milestone, many resources would have to be invested in afforestation and reforestation programmes to restore most of the degraded ecosystems. This directly translating into restoration of degraded landscape and enhances productivity that supplements livelihood at household level.

4.6.2.7 Sessional Paper No. 10, 2014 on the National Environment Policy

Table 44: Sessional Paper No. 10 of 2014 on the National Environment Policy

Legislations	Average Level of awareness (%)

		Aware
	Natural resources management for the current and generations to come for livelihood and socio economic security among the Kenya population.	5

Source: Researcher, 2019

The conventions potentially could improve the livelihood of forest communities if forest resources were conserved and protected sustainably. PELIS, grazing and herbs collections are primary sources of forests resources when they are well protected. However, only 5% of the CFAs were aware of the potential of the law in mitigating food security issues.

4.6.2.8 Sessional Paper No. 3, 2009 on National Land Policy

Table 45: Level of Awareness on Sessional Paper No. 3 of 2009 on National Land Policy

Legislations	**Average Level of awareness (%)**	
Protection of catchment areas and creation of joint management approach for sustainability of land resources for livelihood and socio economic challenges.	**Aware**	**Unaware**
	5	95

Source: Researcher, 2019

The piece of legislation addressed the degraded areas by developing extensive land use for immediate consumers of the resource (local communities). It further targets participatory management of forests resources, by upholding the traditional forests management methods and benefit sharing mechanisms. A combination of these initiatives have a direct bearing on land productivity that eventually addresses livelihood and associated socio economic insecurities.

Table 46: Summary of Policy and Legislative strengths on awareness on livelihood support projects

Legislations	**Average Level of awareness (%)**

Forests Act, 2005 and related Amendments	21
EMCA, 1999 and related Amendments	10
Agriculture (Farm Forestry) Rules 2009	20
The Constitution of Kenya	50
The Kenya Vision 2030 on Forests cover	20
Forests and the Big 4 agenda	15
The Natural resource (benefit sharing) Bill	5
International Conventions and Obligations	2
Sessional Paper No. 3 of 2009 on National Land Policy	1

Source: Researcher, 2019

Introduction of livelihood component in forest sector investment was a strategy to spearhead forest cover improvement. Many countries around the globe were currently engaged in PFM initiatives primarily to improve tree cover while enhancing on livelihood component (Ongugo *et al.,* 2007). In Kenya, there were many pieces of legislation that support livelihood in the context of environmental conservation. However, a huge population of CFAs were not aware with existence of such legislations attributing it to non-existence public participation. This therefore provided a gap on the level of awareness and knowledge on the provision.

4.6.2.9 The influence Equity in Forests Resource Sharing in Forested Ecosystem

Though, consumption of forests resources has been imbalanced in several scenarios, several attempts have been done for legislative interventions. Some of the laws that influence distribution of forests resources are as follows:

4.6.2.10The Forests Act, 2005

Table 47: Forests Act, 2005 influence on Equity and benefit sharing

Legislations	Average Level of awareness

		(%)
	The Forests Act, Part VI, section 53) reads in part *An investment in a forests resources must address equitable share of forests resources with the host community in areas of road construction, education and health facility improvement and employment among other socio corporate responsibilities*	**Aware** 5

Source: Researcher, 2019

Only 5% of the participants were aware that an invester in the forest sector should share parts of the proceeds in the development of social facilities that benefit the forest communities. Any invester, both local and international must contribute to the communities in areas of infrastructure, education, health and employment. The provision advocates for benefit sharing of forest resources with the communities in the forest areas.

4.6.2.11 Natural resource (Benefit) sharing) Bill, 2018

The Bill classifies forests as one of the Natural resources and further creates a Resource rationalization team that manages options for equal share resource rationalization and consumption. The Government (KFS) which is a major shareholder in the forests sector did not provide for engagement with the communities on how to share forests resources especially royalties from forest sales.

Part V1 Section 9(1) ...*all aggrieved persons or stakeholders to sign a joint memorandum before actual operations commences.* Part V1 Section 9(2) *the memoranda is supposed to include benefits that are not financial in nature.* Part V1 Section 10(1) there was an Established Committee that oversees resource rationalization and consumption based on guiding principles. The five provisions of the Bill had a meagre 11.25% of the approval among the pubic, a showing an indication of a huge public participation deficit on the legislations.

Table 48: Natural resource (benefit) sharing) Bill, 2018 on Equity and benefit sharing

Legislations	Average Level of awareness (%)
	Aware
Part V1 Section 9(1). *Development of a Memorandum on the Equitable consumption of Natural Reso*urces.	5
Part V1 Section 9(2) *Sharing of Natural Resources should include projects that do not generate financial returns.*	5
Part V1 Section 10(1) The *Bill establishes a Committee at County level that oversees resource rationalization and equitable consumption.*	5
Part 1 Section 3 classifies forests *as a natural resource with integrity as major guiding principles.*	30

Source: Reserchер, 2019

The five provisions of the Bill have a meagre 11.25% of the approval among the pubic, a clearing indication of a huge public participation deficit on the legislations. Part V1 Section 9(1) of the Bill enlightens the forest community to develop memoranda with Authorities before exploitation commences. The Bill also classifies forests as one of the Natural resources use consumption must be shared with the neighboring communities. These are critical provisions that the public must be made aware of. The forest resources are communally owned, hence falls under the Tragedy of Commons. This explains why the consumption must be communal not individual. Part V1 Section 9(2), therefore provides for non-monetary. Infrastructure projects with large and common consumption therefore offers the best sharing strategy. The modalities are therefore coordinated by the County based resource rationalization entity. EMCA also provides for anybody holding an access permit of any natural resources, trees included shall enjoy all benefits arising from it like the transfer of *Adonsonia digitata* (Baobab trees).

Table 49: Analysis of Awareness of various legislations on Forest Resource Sharing

Legislations	Average Level of awareness (%)

	Aware
Forests Act, 2005 and related Amendments	5.0
The Natural resource (benefit sharing) Bill, 2018	11.25

Source: Researcher, 2019

Table 49 above shows that only 5% of the public were aware of the sections of the Forest Act that provided for benefit sharing while only 11.25% of them were made aware of the Benefit sharing Bill, a critical legislation that would operationalise the consumption of forest resources into equitable manner once it become effective. A large number of the rural folk lagged behind on most development agenda being undertaken to address livelihood. Politicians tended to be on the driving wheel on all aspects of livelihood concern in the society. Figure 12 below graphically presents the rate of awareness among the public.

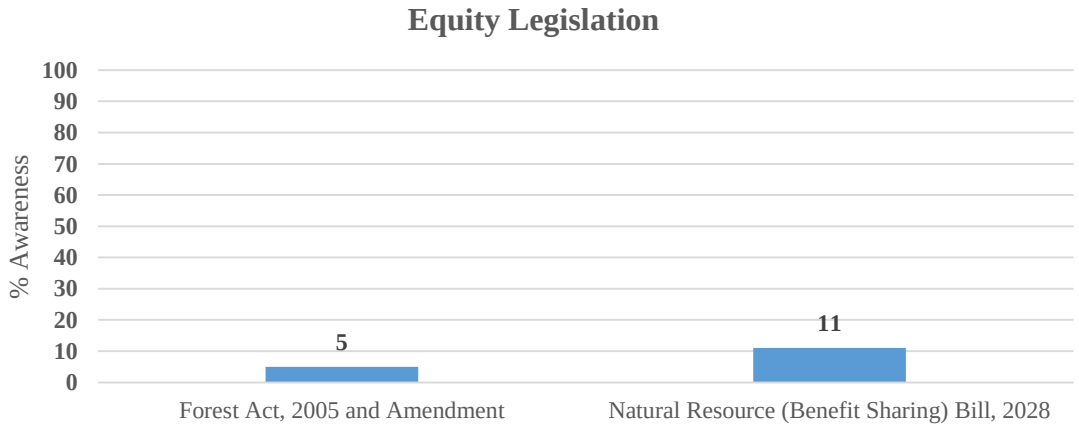


Figure 12: Awareness on Equity legislations in Kenya

4.6.2.12 Chi Square analysis on Consistency of Awareness on Policy and Legislation Gaps

When testing relationship between categorical variables, The Chi Square statistic was found to be ideal. It was therefore computed as below:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

Where f_o = the observed frequency (the observed counts in the cells) and f_e = the expected frequency if no relationship existed between the variables. In summary the

null and alternative hypothesis were defined as: H_O: the variables are independent, there isno relationship between the two categorical variables, knowing the value of one variable did not help to predict the value of the other variable, while H_1: the variables is dependent, there was a relationship between the two categorical variables. Knowing the value of one variable helped to predict the value of the other variable. In this research, Chi Square test was used to examine if the level of awareness of CFA members on forest cover, livelihood and equity was consistent with policies and legislation. Table 50 below shows the level of awareness among the CFA members in the study area.

Table 50: Level of awareness (%) among CFAs

	Forest cover (%)	**Livelihood (%)**	**Equity (%)**
Policies	16.25	9.6	5.0
Legislations	27.66	18.2	10.4

Source: Researcher, 2019

The null and alternative hypothesis are defined as H_O: the level of awareness is not consistent while H_I: the level of awareness is consistent. This computed results were as X-squared = 30.153, df = 2, p-value = 2.833e-07.

In order to identify the consistency of awareness on policy and legislative gaps on the thematic areas of forests cover, livelihood improvement and equity, a chi square was run to determine the homogeneity where null hypothesis (if the level of awareness is not consistent) and alternative hypothesis (if the level of awareness is consistent). The results showed that data observed p value was less than 5% level of significance and the null hypothesis was rejected and subsequently concluded that the level of awareness on forest cover, livelihood and equity was consistent with policies and legislation. The following factors contributed to lack of awareness on policy and legislation.

Table 51: Factors affecting awareness on environmental legislations among CFAs

Factors limiting access to information (Legislations)	**Approval (%)**

Inadequate Participation	93
Lack of Awareness	67
Reluctance from Public officers	57
Little interest from the public	33
Restricted distribution of copies of new legislations i.e. BBI	53
Failure from political leadership	83

Source: Resaercher, 2019

Inadequate public participation was key to unlock public access to various legislative reforms in the country. During the Focus Group Discussion, it was observed that majority of Kenyans tended to pay attention to the political class and were largely influenced by political agenda. Active participation on other development agenda without the politicians had elicited little preference. Most legislation had recorded little participation with 93%, with political contributing 83% failure to enlighten the public. Public participation had been ineffective in many countries, especially in Africa, where politicians tended to drive development agenda instead of the technocrats (GoK, 2018).

4.6.2.13 Chi Square analysis to test on Consistency of Unawareness on Policy and Legislations Gaps

Test hypothesis on consistency of unawareness on policy and legislations gaps. Chi – square was used to test of homogeneity as null hypothesis (level of unawareness is not consistent) as alternative hypothesis (level of unawareness was consistent). The table below shows level ofunawareness (%) on policy and legislation.

Table 52: Level of Unawareness on Policy and Legislations

	Forest cover	**Livelihood**	**Equity**
Policies	86.6	90	95
Legislations	74.34	81.8	89.5

The conclusion was that observed X-squared = 59.916, df = 2, p-value = 9.758e-14. The value is less than 5% level of significance, the null hypothesis was therefore rejected and concluded that the level of unawareness was consistent across policy and legislations in forest cover, livelihood and equity.

4.6.2.14 Chi Square analysis on relationship between Awareness and Unawareness on Policy and Legislative Gaps

The analysis is meant to examine if the Level of Awareness on Policy and Legislative Gaps and Lack of Awareness on Policy and Legislative Gaps were independent for forest cover. The table below summarizes the levels of Awareness and Unawareness.

Table 53: Level of Awareness and Unawareness on Policy and Legislations among CFAs

		Awareness	Lack of Awareness
Policies	Forest Cover	**16.25**	86.6
	Livelihood	**9.6**	90.0
	Equity	0	0
Legislations	Forest Cover	**27.66**	74.34
	Livelihood	**18.2**	81.8
	Equity	**10.4**	89.5

Source: Researcher, 2019

The hypothesis was operationalised as follows: Null hypothesis (awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent) and Alternative Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent showing the following Computed results were as; X-squared = 3.24, df = 1, p-value = 0.07186. The p value is greater than 5% level of significance and therefore failled to reject the null hypothesis. The conclusion was that awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent meaning for the forest cover. Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps depended on each other. The focus is to examine if the level of awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent for livelihood. It was also operationalided as follows: Null hypothesis: Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent, while Alternative: Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps are independent. The computed results were as, X-squared = 2.3787, df = 1, p-value = 0.123. The result showed that the p value was greater than 5% level of significance and therefore failed to reject the null hypothesis and concluded that Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent meaning for the forest cover. Awareness on policy and legislative gaps and

lack of awareness on policy and legislative gaps depend on each other. The focus was to examine if the level of awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent for livelihood. It was also operationalised as follows: Null hypothesis: Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent.

Alternative: Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent. The computed results are: X-squared = 2.3787, df = 1, p-value = 0.123.The p value is greater than 5% level of significance and we therefore fail to reject the null hypothesis and concluded that awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent meaning for the livelihood. Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps depended on each other.

The focus was to examine if the level of awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent for equity.Null hypothesis was Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were not independent and the Alternative hypothesis was awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps were independent. The computed results were: X-squared = 8.0264, df = 1, p-value = 0.00461. The p value is less than 5% level of significance and we therefore reject the null hypothesis and conclude that Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps are independent meaning for the livelihood, Awareness on policy and legislative gaps and lack of awareness on policy and legislative gaps did not depend on each other.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

In objective one which determines the contribution of PELIS (Number of seedlings planted) on forest cover in Lembus, it was found out that the pairwise correlation was statistically significant

between the size of forest planted under PELIS and the number of seedlings planted between 2015 to 2019. The correlation coefficients (p) was found to be positive, within an interval of 0.905 and 1.000. This meant that the growth in the forest area was directly proportional to the number of seedlings planted over the five-year period. These results justified the strength of the association between forestland set aside for planting and the extent of the seedling planted on it.Thus, a correlation coefficient $p = 0.905$ and above (Table 4) exhibit a large effect size, that is, large practical significance. Apparently, there was a large contribution of PELIS (number of tree seedlings planted) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem.

In objective two which determines the contribution of PELIS (Forest product yields) to Forest cover in Lembus forest ecosystem, the pairwise Spearman rank correlation coefficients showed that the association between the size of forest planted under PELIS and annual mean maize yields during the years 2015 to 2019 was generally positive (moderate to very strong, i.e, $p = 0.429$ and $p = 0.857$), respectively. Although the correlations between 2015 and 2016 were positive but non-significant ($p = 0.429 - 0.595$, $p > 0.05$), the influx of stronger and significant relationships could be realized in the subsequent years. The highest correlation coefficient $p = 0.857$ (Table 7) exhibit a large effect size, that is, large practical significance. However, the lowest correlation coefficient, $p = 0.429$ shows medium effect size and hence meduim contribution. Apparently, there were medium to large contribution of PELIS (annual mean maize yields) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem.

In objective three which determines the contribution of PELIS (Forests products income) to the CFA Livelihoods in Lembus forest ecosystem it was found that maize income showed moderate positive relationship with both school transition and investments (commercial buildings, apartments, borehole) in 2019 ($p = 0.464$, $p > 0.24$), beans income in 2019 ($p = 0.238$, $p > 0.05$) and herbs income in 2019 ($p = 0.265$, $p > 0.05$). There was small to medium contribution of income of maize to school transition (effect size varies from small ($p = .060$) to medium ($p = 0.464$). Hence, there was small to medium contribution of income of maize to construction of commercial buildings and boreholes. In case of school transition, the effect size was small ($p = 0.143$) and ($p = 0.238$). Hence, there was small contribution of income of beans to school

transition. Apparently, there were small contributions of income of beans (effect size p =0.143, and p =0.238 to construction of commercial buildings and boreholes; income from medicinal herbs (p =0.036, and p =0.265) to school transition; and construction of commercial buildings and boreholes (effect size, p =0.036, and p =0.265).

The fourth objective which analyses the cost and benefits on PELIS on CFAs in Lembus forest, T- Test analysis showed that the difference between the two means was statistically significant, ($t(28) = 2.213$, $p<.05$). The general analysis, noted that the costs incurred by CFA members in PELIS was more that the benefits accruing from the practice. The benefits from the PFM was expressed in terms of sales of maize and beans under the PELIS programme, and sales of herbal medicine and fuel wood by CFA members in Kenya schillings.

5.2 Conclusions

In objective one, it could be concluded that there was a large contribution of PELIS (number of tree seedlings planted) on forest cover (size of forests planted) in all the eight forests blocks in Lembus forest ecosystem. This large contribution of number of seedlings planted to size of forests planted underscored the effectiveness of community involved reforestation programs in restoring degraded forest ecosystems.

In objective two, there were medium to large contribution of PELIS (annual mean maize yields) to forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem. Whereas beans yields had small to medium to large contributions of PELIS (annual mean beans yields) on forest cover (size of forests planted) in eight forests blocks in Lembus forest ecosystem. Seemingly, increasing crop production under PELIS promoted tree planting which might have contributed to increased forest cover.

In Objective three, it could be concluded that income from PELIS (Maize and beans) and herbs did not have a strong influence over livelihood of the CFAs. This was attributed to the fact that the correlation between mean maize, beans and herbs income was not statistically insignificant. The lack of significant influence indicated that while initiatives like PELIS might have contributed to household income, they might not directly influence livelihoods of the local people. However, they demonstrated some moderate effects towards the year 2019 on livelihood.

This underscored the importance of adopting a more integrated and multi sectoral approach when designing interventions aimed at enhancing livihood on forest adjacent communities.

The fourth objective showed that costs were higher than the benefit accruing after a long period. Statistically, the output from PELIS was less than the output. Though there were immediate, moderate results on the livelihood projects i.e. school transition, investments, results showed imbalanced effects on consumption.

Finally, about 80% of the Lembus farming community are unaware of the legislation and policies that govern tree cover, livelihood and equity. Though there are several legislations (21 pieces of legislation, policies and conventions) addressing the three thematic subjects, less than 20 % are aware of their existence to tap their potential. This has resulted into a serious information gap that require an urgent intervention to resolve. It was observed the public participation on development agenda as enshrined in the constitution was weak, save for the Constitution of Kenya, 2010 that attracted 50% public knowledge. Other critical environmental legislations like the Forests Act, 2005 and EMCA. About 1999 still lacked public knowledge and more importantly, the two pieces of legislations are the main drivers of the Ten Billion Forest Cover Campaign towards the attainment of the desired results (30%) forest cover by 2032.

5.3 Recommendations

In objective one, there was a positive relationship between forest area and the seedlings planted therein. The forest plantation establishment using *Cuppress lusitanica, Pinus patula and Eucalyptus saligna* seedlings resulted into increased forest cover. These three tree species should therefore be a encouraged among the forest communities in Lembus ecosystem. There was therefore a need to mobilize the CFAs to continue planting more seedlings in the forest as the survival rate was high.

In objective two, the study found out that beans production had a strong influence on the size of forests. It should therefore be recommended that more beans needed to be planted because it resulted into a positive influence on forest cover. Similarly, maize too had to be established to enhance more forest cover. To optimize on the potential of PFM, other user rights or practices like bee keeping, ecotourism among others should be encouraged.

In objective three, the relationship between maize and beans were moderate on school transion and investments. This means there should be additional factors such as household income diversity, access to vocational training, social support mechanisms, and educational infrastructure, which may play a more critical role in facilitating successful school transition pathways.

On Cost benefit analysis, there was imbalance between input and output. There was need to strike a balance like provision of more incentives to CFAs. There should be a review of PFM rules and guidelines and CFAs should be incorporated in all levels of decision-making processes.

Finally, the level of awareness and unawareness across policy and legislations in forest cover, livelihood and equity was consistent. The immediate intervention is massive public awareness creation through all available platforms. Lack of knowledge and awareness has contributed to decline on tree cover in the country. The law on concession should be operationalized into a Regulation. The law on concession has not been operationalized into regulations since the new forest law came to effect. Further, sustainable management of hilltops and hillsides in EMCA, 1999 should be operationalized into regulations to facilitate tree planting on such sites. NEMA to scale up EIA enforcement on logging and excision to facilitate tree growing in the affected areas.

5.4 Areas for Further Study

The relationship between Maize and beans have been found positive in increasing the forest cover. Future studies should focus on other crops to assess the relationship. The suitability of other tree species apart from *Cupressus lusitanica, Pinus patula* and *Eucalyptus saligna* should also be assessed for suitability of plantation establishment.

An investigation should have done to show how forests resources, especially PELIS can be shared equitably between the local communities and the forest authorities. Currently the consumption tends to be inbalanced.

There are other factors that contribute to increased forest cover under PFM. These include forest protection, forest fire control. A study should be done to assess their contribution to forest cover improvement.

The Kenyan forest authorities are currently engaging various players in the forest sector to phase-out maize crop within the PELIS system. The study result shows that maize crop within PELIS had great influence on the socio economic status the local communities. Upon enforcement of proposed amendment, study should be done to investigate the impact of PELIS without maize crop component as a factor in the livelihood improvement.

The positive influence of PFM had been evidenced by an increased forest cover. However, a further study should be done to investigate the influence of PFM on the biodervisity in the forest ecosystem.

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APPENDICES

Appendix 1: Public consultations with CFAs



Plate 1: Consultation with Chemususu CFA members



Plate 2: Forest allocated for beans growing within Sabatia forest



Plate 3: Focus Group Discussion with Sabatia CFAs



Plate 4: Consultation with Maji Mazuri CFA members

Appendix 2: Questionnaire

Target Group: Community Forest Association Members (CFAs)

1. To determine the influence of PELIS (*Forest plantation Establishment*) on Lembus forests cover.

    a. Personal Data

a. Name of the respondent: ……

b. Gender A) Male B) Female (*Determination of gender that is actively involved in PFM*)

c. Name of the CFA: …… (*Determination of specific CFA that is successful and unsuccessful in PFM practices.*

d. Age: A) 20 – 30 B) 31 – 40 C) 41 – 50 D) 51– 60 E) 61– 70 F) 70 and above (Active age in PFM activities

e. Education level: A) Primary B) Secondary C) Tertiary D) Graduate E) Post graduate (1. *How does PFM address unemployment challenges (Determination of awareness levels)?*

f. Size of land: (Ha) …….. *(Determination of land adequacy*)

g. Employment status: A) GoK employed B) NGO employed C) Self-employed D) (Unemployed (*Determination of PFM as a source of employment).*

h. Socio economic activity: A) Farming B) Business C) Fishing D) Sawmilling E) Sporting (*other activities done besides PFM*).

i. Main activities carried out inside the forest? A) PELIS B) Bee keeping C) Firewood collection D) Ecotourism E) Herbs collection F) Grazing E) Scientific/ Educational (Determination of main activities that define PFM in Lembus).

II. Contribution of PELIS to improved forests cover

a. What was the size of forests under PELIS between 2015 to 2019?

Year	Esageri	Chemususu	Narasha	Maji Mazuri	Koibatek	Sabatia	Chemorgor	Kiptuget
2015								
2016								
2017								
2018								
2019								

The impact of PFM on livelihood

A) What benefits do you derive from the forest (Goods and services you obtain from the forest?) (Tick appropriately) (Benefits obtained from the forest).

	Category		
	Provisional Services	A) Food crops (Which ones) B) Raw materials (wood, bio fuels, plant oils C) Fresh water D) Medicinal resources E) Grazing F) Quarrying G) Saw Milling H) Firewood	I. Maize II. Beans III. Cowpeas IV. Irish potatoes V. Sweet potatoes VI. Carrots VII. Cabbages VIII. Onions IX. Honey
	Regulatory Services	A) Carbon sequestration B) Moderation of extreme events (drought) C) Waste water treatment D) Erosion prevention E) Air quality provision F) Pollination G) Biological control	
	Habitat and supporting services	A) Home for species B) Maintenance of genetic diversity	
	Cultural Services	A) Recreation and physical health B) Tourisms C) Aesthetic appreciation D) Spiritual experience	

From the ecosystem goods and services listed above, which ones you pay to the Forest Authorities

	Category		Amount (Kshs)	How do You rate the payment?
	Provisional Services	A) Food (PELIS) B) Raw materials (wood, bio fuels, plant oils C) Fresh water D) Medicinal resources E) Grazing F) Quarrying G) Saw Milling H) Firewood		1. Low 2. Moderate 3. High
	Regulatory Services	A) Carbon sequestration B) Moderation of extreme events (drought) C) Waste water treatment D) Erosion prevention E) Air quality provision F) Pollination G) Biological control		
	Habitat and supporting services	H) Home for species I) Maintenance of genetic diversity		
	Cultural Services	E) Recreation and physical health F) Tourisms G) Aesthetic appreciation H) Spiritual experience		

PELIS Programme

1. *Are you aware of PELIS?.....A) Yes B) No*
2. *Were you allocated a piece of land inside the forest?.....A) Yes B) No*
3. If No, why……..

4. *What is the average size of land you cultivate in the forest?.....*
5. *What is the allowable minimum (least) allocated by the forest authorities (Ha)*

A) 0.1 - 0.5 ha B) 0.6– 1.0 C) 1.1 – 1.5 D) 1.6-2.0 E) 2.1-2.5 F) 2.6 – 3.0 { }

6. *What is the allowable maximum (highest) allocated by the forest authorities (Ha)*

A) 0.1 - 0.5 ha B) 0.6– 1.0 C) 1.1 – 1.5 D) 1.6-2.0 E) 2.1-2.5 F) 2.6 – 3.0 { }

4. What crops do you produce under the PELIS Programme (Shamba System)?

A	Crops	Tick	Crops	Tick
B	Maize		Irish potatoes	
C	Beans		Sweet potatoes	
D	Cowpeas		Carrots	
E	Kales		Cabbages	

7. *Which crops are for home consumption?*

A	Crops	Tick	Crops	
B	Maize		Irish potatoes	
C	Beans		Sweet potatoes	
D	Cowpeas		Carrots	
E	Kales		Cabbages	

9. How many bags did you sell during these periods?

	Crops	2015 (Kshs.)	2016(Kshs.)	2017(Kshs)	2018(Kshs.)	2019(Kshs.)
	Maize					
	Beans					
	Cowpeas					
	Irish potatoes					
	Sweet potatoes					
	Cabbages					

10. Which projects or activities did you support with the sales from the crops in your family during the periods highlighted above?

Projects	**Tick**	**Project**	**Tick**
Establishment of business (Kindly name if any (SMEs ….		Expansion of farm production	
Expansion of business (Kindly name if any……		Drilling water boreholes	

Payment of school fees (Enrolment in school)		Connection of electricity	
Construction residential houses		Loan repayment	
Construction of business premises		Marriage	

Projects	**(%)**	**Project**	**(%)**
Establishment of business (Kindly name if any (SMEs ….		Expansion of farm production	
Expansion of business (Kindly name if any……		Drilling water boreholes	
Payment of school fees (Enrolment in school)		Labour, fertilizer,	
Construction residential houses		Subsistence	
Construction of business premises		Marriage	

11. Between the years 2007 – 2012 how was the crop production, if you can remember?

Production trend (2007 to 2012)	Tick		Tick
Very low		High	
Low		Very high	
Moderate			

12. Between the years 2013 – 2019 how was the crop production, if you can remember?

Production trend (2013 to 2019)	Tick		Tick
Very low		High	
Low		Very high	
Moderate			

Other incomes from forest product

	Forest products	Kshs.

13. **Participatory forest management:** a forest management approach, which involves

- ✓ CFA member (***You as the respondent)***
- ✓ The government (KFS), Stakeholders (NECOFA, Lembus Forests Integrated programme, Lembus Council of Elders. KECOCO) in management of forests within a view to improve your livelihoods through empowerment, involvement, consultation and information.

*In view of **these stakeholders**, can you name stakeholders who have been involved in the PFM initiative in Baringo?*

1. . ……2. ……

a) *Since the introduction of participatory forest management programme in 2007, to what extent has it Improved your livelih**ood?***

	Rate of improvement of livelihood	**tick**	**Rate of improvement of livelihood**	**tick**
	Low		High	
	Moderate		Very high	

b. *In future, how do you want it to be done differently*……..

Interventions	Tick	Interventions	Tick
Improved public participation		Policy and legislative amendments and reforms	
Reduced Royalties paid to the GoK		Trainings and capacity building	
Increased incentives and support to the community		Equitable share of forest resources	

c. *Does this require policy and legislative amendments?.....*

Appendix 3: QUESTIONNAIRE A: CFA MEMBERS

To analyze equity in participatory plantation establishment and livelihood scheme **(PELIS**) in Lembus forest. Examine production from PELIS and what the KFS gets in return to PELIS: is there equity in sharing

To determine forest resource benefit sharing criteria between the communities and the government.

1. What are the best ways in sharing of forest resources in Lembus forest block under the Plantation Establishment and Livelihoods Scheme (PELIS)?

*2What are the goods and services do you obtain from the forest (**Analysis of Equity)?***

	Category		
	Provisional Services	J) Food K) Raw materials (wood, bio fuels, plant oils L) Fresh water M) Medicinal resources N) Grazing O) Quarrying P) Saw Milling Q) Firewood	
	Regulatory Services	R) Carbon sequestration S) Moderation of extreme events (drought) T) Waste water treatment U) Erosion prevention V) Air quality provision W) Pollination X) Biological control	
	Habitat and supporting services	C) Home for species D) Maintenance of genetic diversity	
	Cultural Services	2. Recreation and physical health 3. Tourisms 4. Aesthetic appreciation 5. Spiritual experience	

*3. Which ones among the above do you pay for their services (**Analysis of Equity)***

Category		Amount (Kshs)	Rate the payment
Provisional Services	I) Food (PELIS) J) Raw materials (wood, bio fuels, plant oils K) Fresh water L) Medicinal resources M) Grazing N) Quarrying O) Saw Milling P) Firewood		**Low** **Fair** **High**
Cultural Services	I) Recreation and physical health J) Tourisms K) Aesthetic appreciation L) Spiritual experience		

4. What is the main source of the government revenue from forest sales above?

	Sources	**Tick**
	Timber	
	Water	
	Fuel wood	
	PELIS	

5. From PELIS, how has been the yield output since 2007?

	Yield out put	**Tick**
	Low	
	Moderate	
	High	

6. *How much have you paid the Forest authorities for PELIS since 2007?*

	Revenue (Kshs.)	**Tick**
	Low	
	Moderate	
	High	

7. *According to you, is there a balance or profit made from the crops production?*

	Response	**Tick**
	Yes	
	No	

8. *If No, what do you suggest to be done……..……*
9. *According to you, has there been fairness in allocation of farms in the forest?*

	Response	**Tick**
	Yes	
	No	

10. *If No, why……..*
11. *How many registered saw millers are in this CFA?*

12. *How many are engaged in saw milling industry from this CFA but operating in other CFAs or areas?*

13. *Do you apply fertilizer in your farms A) Yes B) No?*
14. *If yes, how much do you use A) Low B) Moderate C) High D) Very high*
15. *How is the production between the amount you spend and the amount of harvest?*
    A) *Low input - High production*
    B) *High input – Low production*
16. *Is there a procedure through which the forest authorities use to qualify saw millers? Kindly highlight*

	Tendering process	
	Open tendering (mostly recommended and used because anyone can fill it)	
	Restricted / Limited tendering	
	Request for proposals	
	Request for quotation	
	Single source	
	No tendering at all	

17. Enumerate some projects within the CFA that are supported by the Kenya Forest Service through the forest proceeds?

	Projects	**Tick**
	Road construction	
	Construction of social amenities (schools, churches, hospitals etc.)	
	Child education sponsorship	
	Development of Water resources	
	Establishment SMEs i.e. Jua Kali artisans, tree nursery	

18. Indicate in the table below on how forest products sales and proceeds are distributed to various projects in the CFA

	Percentage (%) of forest product sales and proceeds	Projects

17. *If No, what could be your guiding principle towards efficient, fair stable revenue sharing of forest resources?* ***Do you believe that the forest resources should be shared using the following principle?***

	Principle	**Tick**
	The objective should be clear	

	Align revenue sharing system with its objectives	
	Keep the expenditure responsibilities in mind	
	Choose appropriate revenue streams and fiscal tools	
	Make any revenue transfer formulae and enforceable	
	Achieve a consensus on the formulae	
	Make revenue sharing transparent and easily auditable	

17. Can you suggest better ways of sharing forest resources?

	Methods

17. Under the PELIS Programme, kindly highlight some of the successes and shortcomings?

Successes

1. ……
2. ……
3. ……
4. …….

Shortcomings

1. …….
2. ……

Appendix 4: FOCUS GROUP DISCUSION (FDG)

Determination of policy and legislative gaps for forest community livelihoods and ecological sustainability of the forest ecosystem:

Target Group: Lembus Council of Elders and Local NACOFA officials

1. *What are the policy options to address livelihoods and forest condition (species diversity and abundance and benefit sharing* ***Complete the table below?***

Since the operationalization of the forest act, the following have been identified as KEY in the implementation of PFM. Are you aware of them? No / Yes

	Yes	***No***	***Sector***
That the Community capacity building on how community rights can be enhanced on the joint management of forests.			
The provision of incentives and benefit sharing (The Forests Act, Part VI, section 53)			
All investors in the forest sector to share the benefits accruing from that investments with the local community in areas like infrastructure and social amenities like schools, hospitals and churches			
The Cabinet Secretary for the National Treasury, with the recommendation by the Cabinet Secretary for Environment, is supposed to propose tax and other fiscal incentives to increase investments in forest land use and forest resource utilization in order to promote forest conservation and management in a bid to increase the forest cover.			
Part VI, Section 53 of the Act, emphasizes on benefit sharing with reference to investors in the sector, **but fails to provide the same with the forest authorities (KFS) which is the key lead agency in the sector.**			
Part 1X removes privileges to access forest area by punitive offences, by illegalizing entry into the forest between the hours of 7 p.m. and 6 a.m., thus contradicting Privileges as envisioned in Part V Section 48 (1) of the Act.			
The current amended Forests Conservation and Management Act number 34 of 2016 does not expressly provide for benefit sharing between the Government and			

communities, however, it does provide on the same between the communities and investors (Part V Section 48).			
The Natural resource (benefit sharing) Act, provides for the establishment of County benefit sharing committee to oversee resource rationalization and consumption, and further classifies forests as one of the Natural resources. According to the Forest Act, the government (KFS) which is a major shareholder in the forests sector does not provide for engagement with the communities on how to share forests resources especially royalties from forest sales.			

2. *Based on the above, what do you think should be done differently to address the livelihoods and forest status improvement?*

Conflicts	**Solutions**
Community capacity building on how rights can be enhanced on the joint management of forests.	
The provision of incentives and benefit sharing (The Forests Act, Part VI, section 53)	
All investors in the forest sector to share the benefits accruing from that investments with the local community in areas like infrastructure and social amenities like schools, hospitals and churches	
The Cabinet Secretary for the National Treasury, with the recommendation by the Cabinet Secretary for Environment, is supposed to propose tax and other fiscal incentives to increase investments in forest land use and forest resource utilization in order to promote forest conservation and management in a bid to increase the forest cover.	
Part VI, Section 53 of the Act, emphasizes on benefit sharing with reference to investors in the sector,	

but fails to provide the same with the forest authorities which is the key lead agency in the sector.	
Part 1X removes privileges to access forest area by punitive offences, by illegalizing entry into the forest between the hours of 7 p.m. and 6 a.m., thus contradicting Privileges as envisioned in Part V Section 48 (1) of the Act	
The current amended Forests Conservation and Management Act number 34 of 2016 does not expressly provide for benefit sharing between the Government and communities, however, it does provide on the same between the communities and investors (Part V Section 48).	
The Natural resource (benefit sharing) Act provides for the establishment of County benefit sharing committee to oversee resource rationalization and consumption, and further classifies forests as one of the Natural resources. The government which is a major shareholder in the forests sector does not provide for engagement with the communities on how to share forests resources especially royalties from forest sales.	

3. *In your opinion n, how can the livelihood of forest dwelling communities be improved under the PFM initiative*

Economic livelihoods for forest dwelling communities	1. 2.

Appendix 5: Key Informat Guidelines

Name of the Organization / Department ……

A) Personal background

1) Name of the officer…….
2) Designation: ……..

B) Status of forest in the Baringo County

*1) What is the size of **tree** cover in Baringo County?*

	Status ***(Kindly specify if possible, i.e. 10 ha, 20 etc.)***	*Specify*
	Do Not Know	

19. What size is under the management of the County Government of Baringo

	Status ***(Kindly specify if possible, i.e. 10 ha, 20 etc.)***	*Specify*
	Do Not Know	

*20. What is the size of forest **cover** in Baringo County?*

	Status (Kindly specify if possible)	*Lembus Forest*	*Entire Baringo county*
	Do Not Know		

1. *What is the size of indigenous forest cover in Baringo County?*

	Status (Kindly specify if possible)	*Lembus Forest*	*Entire Baringo county*
	Do Not Know		

2. *What is the size of forest plantation cover in Baringo County?*

	Status (Kindly specify if possible)	*Lembus Forest*	*Entire Baringo county*
	Do Not Know		

3. *Is there a portion or percentage (%) of the forest product sales i.e. timber, quarry etc. that is directed to the County Government treasury?*

4.	*Response*	*Tick*
	Yes	
	No	
	Not aware	

5. *If yes, how much (%)*

6.	*Rate (%)*	*Specify*

9. *If No, what's the way forward i.e. how should the forests and other natural resources be shared among the CFAs, County Government and other stakeholders?*

Suggestions

10. Do you think this requires legislation at County or National Assemblies?

	Response	***Tick***
	Yes	
	No	

11. Are you aware of the Natural Resource (Benefit sharing) Bill, 2018?

	Response	***Tick***
	Yes	
	No	

12. *What could be your guiding principle towards efficient, fair stable revenue sharing of Natural resources e.g. forest, wildlife, minerals etc.*

	Principle	**Tick**
	The objective should be clear	
	Align revenue sharing system with its objectives	
	Keep the expenditure responsibilities in mind	
	Choose appropriate revenue streams and fiscal tools	
	Make any revenue transfer formulae and enforceable	
	Achieve a consensus on the formulae	
	Make revenue sharing transparent and easily auditable	

13. What are the challenges of forest management in Baringo?

Challenges

14. What role does your Department play in the management forests and other natural resources in Baringo?

Roles

15. *Candidates enrolment in high school between 2015 to 2019*

Year	**Boys**	**Girls**	**Totals**	
2015				
2016				
2017				
2018				
2019				

16. Type and number of projects licensed under EMCA regulations

Year	**EIA**	**EDL**	**EA**	**Waste Transport**
2015				
2016				
2017				
2018				
2019				

18. What roles do CFAs play in the protections of forests under participatory forest management (%) (Tick as appropriate)?

Functions offered by CFAs under PFM	*Maji Mazuri*	*Chemususu*	*Narasha*	*Sabatia*	*Esageri*	*Koibatek*	*Chemorgor*	*Kiptuget*	*Mean Rate*
Protection and conservation (PELIS)									
Implementation of PFMPs									
Protection of sacred areas									
Fire fighting									

APPENDIX 6: Ecological status of the forest ecosystem, 2006

Forest Block	*Hydrological Status*	*Dominant tree species*	*Endangered species*
Maji Mazuri	Permanent and seasonal River flow fluctuating volumes of water	**Plantation***: Cupressus spp* *Pinus spp* and *Eucalyptus* Spp. **Natural forest** *Olea africana*, *Prunus africana* *Urtica urens* *Cedrus brevifolia* *Juniperus procera* *Olea capensis* *Urtica urens* *Cedrus brevifolia* *Juniperus procera* *Acacia tortilis*	*Prunas africana*
Chemorgok	**Two major rivers:** Kerio River Perkerra River	**Plantation** *Cupressus lustanica*, *Eucalyptu*s spp, *Pinus patula Grevillea robusa* *Calistemon citrinas*. *gracillior* *Podocarpus milanjianus,* *Olea hochstetteni,*	*Ocotea usambarensis,* *Arundinaria alpine,* *Podocarpus falcatus* *Juniperus procera*
Esageri	**Rivers:** Esageri, Kapkor and Kaplesir; **Springs:** Kaplesir, Kipsiriche, Senetonik, Olekero, Kapkiyai, Kapkor, Oinetab Moek, Kapkesii and Oinobtich	**Plantation**: Cupressus *lusitanica* *Pinus patula* *Eucalytus saligna* *Grevillea robusta* *Calitis* **Natural** *Juniperus procera*, *Podocarpus gracillior* *Podocarpus milanjianus,* *Polysciaskikuyuensis* *Olea chrysophylla,* *Themeda triandra,* *Hyparrhenia spp,* and *Tarchonanthus camphoratus*	
Kiptuget	Kiptegat Tegat	**Natural forest** *Dombeya species* *Juniperus procera* *Polysias kikuyensis* *Spathodea capense* *Warbugua Ugandensis*	*Warbugia uganandensis*

Forest Block	*Hydrological Status*	*Dominant tree species*	*Endangered species*
		Polysias kikuyensis *Makhamia luta* *Ocotea usambarensis* *Olea africana* **Plantation** *Eucalyptus saligna* *Acasia melanoxylon* *Acasia meansii*	
Koibatek	Ngusu River Biafra Springs Tegat Springs Mututhia River	**Natural Vegetation** *Olea africana* *Sinarudinaria alpine* *Podocarpus latifolia* *Prunus africanus* *Dombeya goetznii* *Croton megalocarpus* *Olea africana* *Urtica urens* *Cedrus brevifolia* *Juniperus procera* *Olea capensis* *Urtica urens* *Cedrus brevifolia* *Juniperus procera* *Acacia tortilis* *Spathadoea nilotica* *Albizia lebbeck* *Vitex keniensis* **Plantation** *Cupressus lusitanica* *Pinus patula* *Pinus radiata* *Eucalyptus sp* *Casuarina*	
Narasha	Perkera Siloi Simoni Kapkurumet Keringet Chepkitach Lang' lang' Kisarget Kapkichorum	**Plantation** *Pinus patula* *Cupressus lusitanica* *Eucalyptus saligna*	
Sabatia	Tumik. Narosura Logoiwee Changwal Soe Ruiyobei Awe	**Plantation** *Cupressus lusitanica,* *Pinus spp, Eucalyptus spp,* *Gravellea robusta*	

Forest Block	*Hydrological Status*	*Dominant tree species*	*Endangered species*
	spring Merigeiywe. Siwot Esageri Yemitik Silibj	**Natural** *Juniperus procera* *Podocarpus milanjianus,* *Olea hochstetteni,* *Olea chrysophylla,* *Ekerbegia capensis*	
Chemususu	River Chemususu Tuyobei stream Muriskisis stream	**Plantation** *Pinus Cupressus* *Eucalytus saligna* *Grevillea robusta* **Natural** Juniperus procera *Syzygium guinensis* *Tamarinda indica* *Euphobia tiricalis* *Makhamia lutea* *Croton macrostachus* *Acasia senegal* *Croton magalocapus* *Ocotea usambarensis* *Warbugua ugandensis* *Spathodea capense*	

APPENDIX 7: Ecological status of the forest ecosystem, 2019

Forest Block	***Hydrological Status***	***Dominant tree species***	***Disappeared spp scanty (2006)***	***Reasons for disappearance***
Maji Mazuri	Permanent River flow with increased water volume	**Plantation***:* *Cupressus spp* *Pinus patula,* and *Eucalyptus* Spp. **Natural forest** Olea *africana*, *Prunus africana*	*Juniperus procera* *Eucalyptus spp* *Prunus africana*	Targeted posts for fencing Removed systematically along the rivers Targeted for herbs
Chemorgok	**Two major** rivers: Kerio River Perkerra River	**Plantation** *Cupressus 147ikuyuensi*, *Eucalyptu*s spp, *Pinus patula* *Grevillea robusa*.	*Grevillea robusta* *Calistemon citrinas*	*Short rotational age* *Short rotational age* *(ban on harvesting)*
Esageri	**Rivers:** Esageri, Kapkor and Kaplesir; Springs**:** Kaplesir, Kipsiriche, Senetonik, Olekero, Kapkiyai, Kapkor, Oinetab Moek, Kapkesii and Oinobtich	**Plantation**: Cupressus *lusitanica* *Pinus patula* *Eucalytus saligna* **Natural** *Juniperus procera,* *Podocarpus gracillior* *Olea hochstetteni, Olea chrysophylla,*	*Grevillea robusta* *Calitis* *Juniperus procera* *chrysophylla, Tarchonanthus camphoratus* *Polyscias kikuyuensis*	*Short rotational age* *(ban on harvesting* Targeted for fencing posts Medicinal value

Forest Block	*Hydrological Status*	*Dominant tree species*	*Disappeared spp scanty (2006)*	*Reasons for disappearance*
Kiptuget	Kiptegat Tegat	**Natural forest** *Olea europaea, Pavetta gardeniifolia, Dombeya burgessiae, Acacia lahai, Juniperus procera, Carissa spinarum syzygium guineense and vepris nobilis.* **Plantation** *Eucalyptus saligna Acacia melanoxylone Acasia meansii*	*Vernonia auriflifera,* *Erythrina abyssinica, Dombeya* *Prunus Africana* *Acacia mearnsii,* *Eucalyptus grandii*	Illegal poaching Short rotational age Systematic removal on the riverine
Koibatek	Ngusu River Biafra Springs Tegat Springs Mututhia River	**Natural Vegetation** *Olea africana Sinarudinaria alpine Podocarpus latifolia Dombeya goetznii Olea africana Urtica urens Cedrus 148ikuyuensi Olea capensis Urtica urens Acacia tortilis Spathadoea nilotica Albizia lebbeck Olea Welwitstchii* **Plantation** *Cupressus lusitanica Pinus patula Pinus radiata Eucalyptus sp*	*Prunus africanus* *Juniperus procera* *Warburgie ugandensis* *Vitex keniensis* *Casuarina* *Eucalyptus sp*	Herbs collection Fencing posts Herbs collection Poached for furniture Dried due to short rotational age Removal on the riverine

Forest Block	*Hydrological Status*	*Dominant tree species*	*Disappeared spp scanty (2006)*	*Reasons for disappearance*
Narasha	Perkera Siloi Simoni Kapkurumet Keringet Chepkitach Lang' lang' Kisarget Kapkichorum	**Plantation** *Pinus patula* *Cupressus lusitanica* *Eucalyptus saligna* **Natural Vegetation** *Olea africana* *Sinarudinaria alpine* *Dombeya goetznii*	*Eucalyptus saligna* *Podocarpus latifolia*	Removal along riverine Illegal removed for high value in furniture
Sabatia	Tumik. Narosura Logoiwee Changwal Soe Ruiyobei Awe spring Merigeiywe. Siwot Esageri Yemitik Silibj	**Plantation** *Cupressus lusitanica, Pinus spp, Eucalyptus spp,* **Natural** *Juniperus procera*	*Gravellea robusta* *Juniperus procera*	Short rotational age Fencing posts
Chemususu	River Chemususu Tuyobei stream Muriskisis stream	**Plantation** *Pinus Cupressus Eucalytus saligna* **Natural** *Syzygium guinensis, Podocarpus falcatus, Podocarpus Latifolia,Olea african. Albizia gumifera, Juniperus procera, polysiscias kuyuensis, Dobeya tor ida,*	*Grevillea robusta* *Juniperus procera* *Prunus africana Olea capensis and Viprous species.*	Short rotational age Fencing posts Herbs collection