PARTICIPATION IN PAYMENT FOR ECOSYSTEM SERVICES (PES) AND ITS EFFECTS ON HOUSEHOLD WELFARE IN MT ELGON, KENYA

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DECLARATION

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

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DEDICATION

I dedicate this work to my parents Mr. and Mrs. Waruingi, and my siblings Loise and Teresiah.

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ANOVA	Analysis of variance
ATT	Average treatment effect on the treated
CFA	Community Forest Association
EPWS	Equitable payments for watershed services
FAO	Food and Agriculture Organization
FCexp	Household food consumption expenditure
FDG	Focus Group Discussion
FIES	Food Insecurity Experience Scale
FUG	Forest user group
HDDS	Household Dietary Diversity Score
HLPE	High level panel of experts
IFAD	International Fund for Agricultural Development
JFM	Joint Forest Management
KEFRI	Kenya Forest Research Institute
KES	Kenyan shilling
KFS	Kenya Forest Service
KII	Key Informant Interview
Km	Kilometres
PELIS	Plantation Establishment Livelihood Improvement Scheme
PES	Payment for ecosystem services
PFM	Participatory Forest Management

PLDL	Paddy Land to Dry Land
PSA	Programa de Pagos por Servicios Ambientales
PSM	Propensity Score Matching
REDD+	Reducing Emissions from Deforestation and forest Degradation Plus
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
$	United States Dollar
VOH	Voices of the Hungry
WFP	World Food Programme
WHO	World Health Organization
WTP	Willingness to pay
WWF	World Wide Fund
ICRAF	World Agroforestry
GCF	Green Climate Fund

ABSTRACT

Forests offer vital economic, social, ecological and cultural benefits yet they continue to be degraded at a higher rate than other natural ecosystems. To reverse this trend, payment for ecosystem services (PES) programs have been promoted with the aim of delivering both sustainable forest use and livelihood improvement to forest communities. Despite the rise in implementation of PES programs, the understanding on its effects on livelihood outcomes is limited, in part because the existing evidence is skewed towards conservation outcomes. This is despite evidence showing that improved forest governance and ecological restoration is dependent on livelihood gains which can only be attained through local communities' participation. Therefore, this study assessed household participation in a payment for ecosystem services and its effect on households' welfare in Mt Elgon, Kenya using a case of the Plantation Establishment Livelihood Improvement Scheme (PELIS). PELIS seeks to enhance community participation in restoration of forest ecosystems through establishment of plantation forests with a dual aim of improving forest cover and local people's livelihoods. The study employed a stratified sampling design to identify three forest stations (Saboti, Kimothon and Kaberwa). Further a random sampling technique was used to obtain a sample of 919 forest dependent households. Pretested survey questionnaires were administered to the 919 households and prior to that, FGDs and KIIs were conducted to corroborate survey findings. A participation index computed from nine key forest activities was used to assess household participation levels. Heck-Poisson model was used to assess determinants of participation and its intensity. Propensity score matching was applied to assess the effect of PES on household food security and income levels. Results from the study reveal that 49 percent of the households participated in the PELIS program. The mean participation index was 5.3 out of a maximum score of 9 indicating an above average participation level. Low participation was observed among poorer households and female headed households. The heck-Poisson results indicate that gender of household head, forest extraction, livestock ownership, ownership of private woodlots, income from PELIS, perception of forest cover change and involvement in forest user group meetings positively influenced the levels and intensity of participation. Age of household head, membership to middle and poorest wealth categories and off-farm income negatively influenced the levels and intensity of participation. Propensity score matching results show that households' participation in PELIS lowered the food insecurity experience score (FIES) score by 0.437. This finding indicated that participation in PELIS positively influenced households' access to food. The results further showed that participation in PELIS positively affected household income; with income from PELIS contributing 40 percent of total income. Assessment of distributional effects revealed that the PELIS program significantly impacted households in the poorest quantiles (1-4) but had no significant effect on upper quantiles (5-9) implying that the program has the potential to reduce poverty. However, in order for the program to make greater contributions in poverty reduction and forest conservation, the study recommends; a) Cost reduction mechanisms to increase participation among women and the poor. These would include waivers on enrolment and registration fees for poor households, in-kind payment such as labour for various forest activities or provision of subsidies for production inputs. Besides, limited access to physical and financial capital

influenced participation in PELIS among the marginalized (poor households and women) in the society. This calls for greater attention to the pro-poor design of PES programs implemented on forest ecosystems to ensure inclusion of eligible and willing households. b) Participation in PELIS contributes positively to outcomes on household food security and incomes. These positive outcomes can inform roll-out of similar programs in other ecosystems offering potential for overall rural development.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Forests play essential economic, social and cultural roles for public and private actors in many rural areas across the world. The ecosystems also provide a range of ecosystem services including; provisioning services e.g. food, fuel and water; support services e.g. nutrient cycling, soil formation and primary production; regulating services e.g. climate regulation, water purification and flood regulation; and cultural services e.g. spiritual nourishment, educational value and recreation (Food and Agriculture Organization & United Nations Environmental programme, 2020). However, forest ecosystems are at risk of irreversible loss due to higher rates of degradation than other natural ecosystems (Wunder *et al*., 2014; Food and Agriculture Organization, 2018). The Global Forest Resource Assessment, (2015) revealed that global forest area declined from 31.6 percent to 30.6 percent between 1990 and 2015 while forest cover in Sub-Saharan Africa (SSA) declined from 32 percent to 27 percent. In the same period, Kenya's forest cover has declined by 12400 hectares/year or at a rate of 0.3 percent annually. The rising degradation rates have in part been fueled by growing population pressure triggering conversion of forestland to agriculture and livestock areas (FAO, 2018). Consequently, the ongoing forest degradation not only threatens livelihoods of forest communities and indigenous people but also affects natural biodiversity (FAO & UNDP, 2020).

Finding a balance between maintaining livelihoods and reducing forest degradation remains a major challenge, since degradation, if unabated, results in a reduction in welfare gains derived from forests and overall negative economic outcomes. Forests have traditionally been managed through a centralized approach characterized by fierce state control and non-involvement of local communities (Chomba *et al*., 2015). However, with the high costs of monitoring and enforcement, there was reduced effectiveness of command and control approaches. Thus, with the failure in the centralized approach, decentralized forest governance has been promoted. Decentralized forest governance involves a shift towards increased inclusion of local

communities in the management and use of forest resources for efficiency and equity in natural resource management (Kimutai & Watanabe, 2016). Decentralized forest governance approaches employ the principle of incentive-based conservation which has gained prominence as a strategy to protect ecosystem services and mitigate climate change while improving community livelihoods (FAO, 2014; Wunder *et al*., 2018; Shapiro-garza *et al*., 2020). Incentive-based initiatives provide monetary or non-monetary enticements in order to encourage communities or individuals to align their land use practices with sustainable management of natural resources (Okumu & Muchapondwa, 2020a).

One such mechanism for incentive-based conservation is Payment for ecosystem services (PES). PES is viewed as a voluntary transaction where ecosystem service users make payments to the providers on condition that they guarantee flow of ecosystem services e.g. clean water and climate stabilization (Wunder, 2015; Wunder *et al*., 2018). While in theory landowners are compensated for conservation outputs, many PES schemes compensate participants for inputs such as trees planted because output (such as clean air, climate stabilization) measurement is problematic (Engel *et al*., 2008; Nguyen *et al*., 2015; Borner *et al*., 2017). PES is designed as a key mechanism to provide incentives for sustainable forest use by local communities with a dual expectation of delivering both conservation and livelihood outcomes (Jack & Jayachandran, 2018; Shapiro-garza *et al*., 2020)

The recognition that PES could deliver on both social-economic and ecological outcomes, has seen a rise in the implementation of such projects in the global south (the less socio-economically developed global regions in Africa, Latin America, Asia, and the Middle East) over the last 20 years. PES schemes have been implemented in various natural resource systems such as watersheds (Mussa & Mwakaje, 2013; Kwayu *et al*., 2014; Bottazzi *et al*., 2018), recreational areas (Mäntymaa *et al*., 2018), rangelands (Asquith *et al*., 2008; Bremer *et al*., 2014) and forests (Arriagada *et al*., 2015; Persha & Meshack, 2015; Liu *et al*., 2019; Méndez-lópez *et al*., 2019; Okumu & Muchapondwa, 2020a). Of all the natural resource ecosystems, forests form part of the largest PES implementation settings due to their important role in water resource management, biodiversity conservation, carbon sequestration and provision of

livelihoods (Engel *et al*., 2008; FAO, 2014). Moreover, forests ecosystems provide essential livelihood options for dependent households through; provision of food, safety nets through commercialization of forest products and employment opportunities which are a pathway for poverty reduction (Angelsen *et al*., 2014; Robinson *et al*., 2016; Kwayu *et al*., 2017). Thus, incentive schemes which pay forest communities in cash or confer them non-monetary benefits such as rights to harvest forest products, provision of farm inputs and capacity building e.g. training in apiculture have grown (Persha *et al*., 2011; Wunder, 2015; Kwayu *et al*., 2017; Kagombe *et al*., 2018). These incentives are hypothesized to enhance local community participation in the management of natural resources for sustainable resource conservation while also generating livelihood benefits for participating communities (Persha *et al*., 2011; Wunder, 2015; Kagombe *et al*., 2018).

There is now growing empirical evidence on PES's effects on three types of outcomes: forest governance, livelihoods and forest conditions. However, the majority of evidence on effect of PES outcomes to date has been biased towards Latin America and Asia (Zheng *et al*., 2013; Adhikari & Agrawal, 2014; Bremer *et al*., 2014; Shrestha & Shrestha, 2017). This is because these regions comprise the largest forest ecosystems globally and PES implementation was first done here (Blackman & Woodward, 2010). Nonetheless, the implementation of PES in sub-Saharan Africa has grown significantly in the past decade and some evidence of the social-economic and ecological outcomes is starting to emerge. While these outcomes seem to happen concurrently, literature has seen a growing emphasis on forest governance (Chomba *et al*., 2015; Kairu *et al*., 2018) and ecosystem restoration (Sagona *et al*., 2016; Kagombe *et al*, 2018) with livelihood outcomes being underemphasized. However, it is critical to note that efficient forest governance and ecological restoration is dependent on livelihood gains which can only be achieved through local communities' participation (Sorice *et al*., 2018).

Despite continued implementation of PES in various ecosystems across the developing world, and its adoption by communities, documented empirical evidence on the topic has not grown in equal measure (Bottazzi *et al*., 2018; Aganyira *et al*., 2020). The existing evidence shows that socioeconomic, institutional, and administrative factors

influencing participation vary contextually and the direction of influence of these attributes remains uncertain (Coulibaly-lingani *et al*., 2011; Bremer *et al*., 2014; Bottazzi *et al*., 2018; Mäntymaa *et al*., 2018). Further, documented literature only has a limited focus on disaggregation of participation by different social groups (Coulibaly-lingani *et al*., 2011; Hegde *et al*., 2014; Sorice *et al*., 2018). Yet, dissagregation in outcome assessment helps to unmask hidden trends in participation, identify vulnerable groups and make them more visible to policy makers.

A key proposition in many studies is that household involvement in PES programs is entirely voluntary (Bottazzi *et al*., 2018; Jack & Jayachandran, 2018; Jones *et al*., 2020). Yet, existing evidence reveals instances where PES programs operate against the "voluntary" principle (Engel *et al*., 2008; Mullan & Kontoleon, 2012) and that administrative selection can dictate who participates and who doesn't. Despite this recognition, only few studies take into account the role of administrative factors in influencing household participation in PES (Pagiola *et al*., 2008; Mullan & Kontoleon, 2012; Hegde *et al*., 2014; Méndez-lópez *et al*., 2019;Okumu & Muchapondwa, 2020a).

Empirical literature on livelihood outcomes of forest-dependent household's participation in PES schemes have now started to emerge. However, much of the literature focuses on income (Mugenya, 2012; Mussa & Mwakaje, 2013; Arriagada *et al*., 2015; Okumu & Muchapondwa, 2020b) with very minimal attention to other livelihood indicators such as food security. The existing literature on PES effects on household income shows both positive effects (Mugenya, 2012; Okumu & Muchapondwa, 2020b) and negative effects (Mussa & Mwakaje, 2013; Arriagada *et al*., 2015). These variations could be because of differences in household participation trends. Thus, unpacking household participation decisions and their determinants is critical in the understanding of the effects of PES on livelihood outcomes of forest dependent communities. Moreover, many studies provide estimation on incomes broadly without disaggregation on the basis of participant's heterogeneity (Mugenya, 2012; Mussa & Mwakaje, 2013; Arriagada *et al*., 2015). Failure to account for the difference in outcomes among the participants based on household characteristics such wealth categories could lead to overestimation or underestimation of livelihood effects. Although variances in livelihood outcomes could be attributed to differences

in PES programs and geographical contexts, methodological differences could also play a key role.

Forests provide food and nutritional diversity, medicine and fuel to about 1.6 billion people globally (FAO & UNEP, 2020). Furthermore, the bulk of the world's poorest people live in forests, with about 200 million indigenous peoples completely reliant on forests for their survival (FAO, 2018). Forest extraction contributes to food and nutritional security in numerous ways including direct provision of food (fruits and vegetables) and provision of energy for cooking (High Level Panel of Experts (HLPE) on Food Security and Nutrition, 2019). While there is growing acknowledgment that forests and tree-based systems enhance farmland agriculture through provision of food security and nutrition (Vira *et al*., 2015), a focus on this dimension of livelihoods has been limited. As a result, the complex, overlying and interconnecting processes which link tree products and services to food security and nutrition are currently not adequately represented in forestry, agriculture, food or nutrition-related strategies at global and national levels.

According to the 2020 State of Food Security and Nutrition Report (FAO *et al*., 2020) the prevalence of moderate and severe food insecurity in Africa is at 52.5 percent with Eastern Africa having a prevalence of 62.7 percent. Moreover, Africa records the highest levels of undernourishment at 19.9 percent with Eastern Africa having the highest levels at 30.8 percent where about seven percent of all Kenyans are undernourished. Thus, it is important to build understanding on the role that PES participation could play in improving the food security situation in Kenya.

1.2 Context of forestry PES schemes in Kenya

Kenya’s forest cover is estimated at 6 percent of the total land-cover, which is below the 10 percent threshold recommended by the United Nations (Republic of Kenya, 2019). The loss in forest-cover is mostly attributed to deforestation, fueled by intense human activities (Kissinger *et al*., 2013; FAO, 2018; Republic of Kenya, 2019). The need to address challenges of forest degradation, has led the government to pursue policies and strategies that transfer management and responsibility of forests to local forest dependent populations (Kimutai & Watanabe, 2016). This strategy is

implemented in Kenya through participatory forest management (PFM), which began after the enactment of the Forest Act (Kenya Forest Act, 2005), which attempted to establish community participation in the co-management of gazetted forests, among other things. The Act calls for the formation of Community Forest Associations (CFAs) (Kairu *et al*., 2018), where forest dependent communities are allowed to extract forest products and engage in forest management together with the state agency in charge of protected forests – the Kenya Forest Service (KFS) (Chomba *et al*., 2015; Thygesen *et al*., 2016). Community extraction of forest products is accompanied with responsibilities such as; protecting sacred groves, establishing plantation forests, firefighting and any other management activities (Forest Act, 2005-Clause 47; (Kenya Forest Act, 2016). Thus, PES schemes are implemented in the context of PFM as user rights accompanied with responsibilities for conservation. This study focuses on the Plantation Establishment Livelihood Incentive Scheme (PELIS); one of the PES schemes rolled out in various state forests with a goal of restoring degraded forestlands.

1.2.1 Evolution of the shamba system in Kenya

PELIS previously started off as a forest plantation establishment program known as *shamba system* from 1910 to 1987. Under *shamba system*, resident workers were allocated by the then Forest Department (FD) areas freshly cleared of trees to plant food crops. They were then expected to tend for trees for about two to three years until trees formed a canopy. This system was introduced with an aim of providing farmers with livelihood and subsistence needs as they helped the government to re-establish industrial forest plantations (Kagombe and Gitonga, 2005). In 1975, the rules in the shamba system were revised to allow other community members to also rent shambas. While the numbers of cultivators significantly grew, most of them did not understand the *shamba system*; supervision got problematic and tree survival rates declined leading to a ban of the system in 1987 and all forest residents were evicted from the forest areas.

No arrangements were made to ensure plantation establishment after the ban and the 1994 staff retrenchment programme worsened the situation resulting in severe labour shortage in forest stations. In 1994, the *shamba system* was reorganized and re-

introduced as Non-Resident Cultivation (NRC). Under NRC, cultivators were prohibited from residing in forest areas. By 1997, NRC had been rolled out in all major forest plantations in Kenya. However, it also struggled but a taskforce review of the implementation of NRC revised the guidelines and presented recommendations for reform, emphasizing on proper management of cultivation areas, involvement of cultivators in reforestation efforts and closure of areas that would not be restored immediately. This system was also flawed with irregularities and following environmental activism was banned in 2004 (Wanjira and Muriuki, 2020). A variant of the system was later introduced in 2007 known as PELIS.

1.2.2 Implementation of PELIS in Kenya

Plantation Establishment Livelihood Incentive Scheme (PELIS) allows forest adjacent communities through CFAs to legally use degraded forestland (forest land previously cleared off existing forests and left bare) for crop production while also establishing tree seedlings (KEFRI, 2014). CFA members are assigned parcels of land in deforested state forests and required to establish commercial forest plantations upon payment of KES 1500 as at 2019 (US$ 15) per plot which is shared between the CFA and KFS at a ratio of 1:2. The share allocated to KFS is used for providing technical assistance to CFAs including in supporting development of the management plan while the share allocated to CFAs and is used for tree nurseries establishment, planting and maintenance of the trees. Participants in the PELIS program are compensated in kind by gaining user rights to engage in certain activities. These include; plantation farming in the parcels allotted until trees are grown and form a canopy; collection of fuel wood, herbal medicine and indigenous vegetables; extraction of timber; and livestock grazing (KEFRI, 2014).

PELIS has been implemented in ten conservancies spread across the country including North Rift, Ewaso North, Central Highlands, Mau, North Eastern, Eastern, Nyanza, Western, Nairobi and Coast conservancies) with the largest plantations being in North Rift and Central Highlands conservancies (Kenya Forest Service (KFS)). PELIS implementation in Mt Elgon forest is an example of an intervention that seeks to provide incentives to local communities for biodiversity restoration. The ecosystem is characterized by a growing population, increased dependence of the ecosystem

services by local communities, a series of land conflicts among area residents and diminishing land resource base (Petursson & Vedeld, 2015; Kenya Water Towers Agency, 2018). It is therefore important to examine outcomes of this program with regard to livelihood improvement for participating households – an objective it seeks to achieve.

1.3 Problem Statement and Justification

Forest ecosystems provide a wide range of social, ecological and economic benefits, yet they continue to be degraded at a high rate (FAO, 2018). Over the last two decades, incentive-based conservation initiatives such as PES have emerged seeking to reduce deforestation while improving their livelihoods through cash or in-kind payment of landowners who participate in these programs. In principle, incentive-based programs such as PES are designed to deliver dual objectives of ecosystem restoration and increased welfare gains to participating households (Clements & Milner-Gulland, 2015). While reduced deforestation is a key goal of PES schemes (Mahanty *et al*., 2013) welfare benefits can only be realized if households choose to participate in the PES program (Bremer *et al*., 2014; Sorice *et al*., 2018).

With growing application in forest ecosystems, the awareness that PES can result in both ecological restoration and livelihood improvement has sparked interest in PES projects (Nguyen *et al*., 2015; Persha & Meshack, 2015). However, much of the documented literature on PES is focused on conservation outcomes (Asquith *et al*., 2008; Shrestha &Shrestha, 2017; Sagona *et al*., 2016) and skewed towards Latin America and Asia (Bremer *et al*., 2014; Hua Zheng *et al*., 2013; Shrestha & Shrestha, 2017) with a limited focus on sub-Saharan Africa (Persha & Meshack, 2015; Kwayu *et al*., 2017). Developing literature in SSA sheds light on livelihood outcomes with a main focus on income. This is despite evidence showing that over 1 billion people depend on forests for food resources globally (FAO, 2018).

While varied outcome effects can be explained by geographical contexts, they could also be attributed to methodological differences. Many studies assess effects of PES on livelihoods using descriptive statistics (Matiku *et al*., 2013; Humphrey *et al*., 2016; Sagona *et al*., 2016) with only very few utilizing counterfactuals (Arriagada *et al*.,

2015; Persha & Meshack, 2015). In addition, many of the existing studies do not disaggregate outcomes across varying social groups yet benefits do not accrue homogenously to different social groups (Clements & Milner-Gulland, 2015; Persha & Meshack, 2015 ; Kwayu *et al*., 2017). Thus, lack of consideration of differences in natural, physical or financial capital and wealth gaps while assessing outcomes may result in biased estimates making it difficult to generalize findings.

This research, therefore, addresses these gaps by assessing the effects of household participation in PES interventions on household income and food security outcomes across participating households. This study extends the existing literature on outcomes of PES by considering both the average and heterogeneous effects of the program on income and food security. Further, an evaluation of drivers of participation in the program helps to shed light on household participation patterns and assist policy makers in making considerations for future implementation of similar schemes.

1.4 Objectives

1.4.1 Main objective

The purpose of the study is to assess participation in Payment for Ecosystem Services (PES) initiatives and its effects on livelihoods of forest dependent households in Mt Elgon, Kenya

1.4.2 Specific objectives

1) To assess participation in PES and its determinants among households in Mt Elgon
2) To evaluate the effects of participation in PES on household food security in Mt Elgon
3) To determine the effects of participation in PES on household income in Mt Elgon

1.5 Hypotheses

The following hypotheses were tested;

1) Household characteristics (demographic, socioeconomic and institutional) have no significant effect on a household participation in PES in Mt Elgon
2) Participation in PES has no significant effect on household food security in Mt Elgon

3) Participation in PES has no significant effect on household income in Mt Elgon

1.6 Significance

The forest ecosystem in Kenya is under threat of extreme degradation owing to increased human activity and encroachment. This poses a serious threat to the ecosystem and development at large considering the contribution that forests make to human livelihoods. This study provides insights and evidence on the nature of PELIS and its contribution to the welfare of households adjacent to the forest. Findings from this study provide the government with key information on how to effectively roll out similar participatory conservation programs to ensure attainment of desired forest cover while improving livelihoods of adjacent forest communities. Moreover, the results provide a basis for policy makers to draft policies that further strengthen involvement of local communities in forest and other natural resource conservation. In addition, this research adds to the limited body of literature on PES participation and its outcomes especially in SSA hence providing a reference point for future studies in the developing world.

1.7 Scope of study

The study was carried out in Mt Elgon forest in Bungoma and Trans Nzoia counties in Kenya. The choice of study area was grounded on a growing population in the region resulting in diminishing land resource base, increased dependence of the ecosystem services by local communities, a series of land conflicts among area residents and long history of involvement in PFM. Hence, the ecosystem may provide crucial lessons on the promotion of PFM across the country and give insights on outcomes of incentive-based programmes under implementation. The ecosystem covers about 72874 ha where part of it is gazetted as a national park and another as a forest reserve. Mt Elgon forest ecosystem is one of the major water towers in Kenya and a key water catchment for Lake Victoria and Turkana in Kenya, and Lake Kyoga in Uganda. Key rivers that are part of the drainage system include Suam River, Nzoia River and Malakisi River which collectively provide water to 166 sub-locations in Kenya (Kenya Water Towers Agency, 2018). In addition to water, the ecosystem also provides services such as wildlife habitat, carbon sequestration and biodiversity conservation. The water tower provides both direct and indirect benefits to local, regional, national and international

communities as a result of its transboundary nature thus it offers a good case for livelihood evaluation.

1.8 Thesis outline

The thesis comprises of five chapters. The first chapter presents the introduction, motivation of study, research objectives and hypotheses, significance of the study and an overview of the study area. Chapter two presents a review of literature, theoretical framework, and conceptual framework applied in the study. Chapter three presents a detailed description of the materials and methods used to analyze study objectives. Chapter four presents the results and discussion and finally Chapter five presents the conclusions and policy recommendations from the research findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on participation in PES schemes and the livelihood effects of participation in payment for ecosystem services. Section 2.1 provides an outline of the theories that inform the study. Section 2.2 provides empirical literature on participation and effects of participation in PES, while section 2.3 highlights the research gap. The chapter concludes in section 2.4 by illustrating the conceptual framework applied in the study.

2.2 Theoretical foundations that inform participation in incentive-based conservation

This research seeks to investigate whether participation in PELIS – a forestry PES scheme in Kenya has an effect on the welfare of forest-dependent households. Literature documents a number of theories that informs the effect of community participation in incentive-based conservation programs and welfare outcomes. These include; the collective action theory, diffusion of innovation theory and classical economic theory.

The collective action theory assert that environmental problems are based on the challenges of collective action i.e. a situation where all actors have to sacrifice individual gains and participate in conservation of a common good (Ostrom and Ahn, 2009). Under this perspective, participation in incentive-based conservation can be regarded as a case of collective action where households decide to collectively commit to environmental protection for the benefit of their community and society. In this scenario, an economic incentive helps to reduce the individual cost dilemma by focusing on the collective nature of participation.

The diffusion of innovation theory provides a basis for understanding the diffusion of conservation practices among communities. Under diffusion, prior adoption of a practice in a population influences the likelihood of probability of adoption for non-adopters where behavior change flows horizontally (through social networks) rather

than vertically (top-down approaches) (Mahajan *et al*., 2021). While this theory fits in understanding participation through behavior change, it does not inform the economic intentions behind adoption of incentive-based conservation.

In the classic economic theory, the assumption is that households make conservation decisions by weighing the benefits and costs associated with participating in these programs and in seeking to maximize utility based on their production decisions. Under this, the utility maximization theory is largely applied to assess individuals as rational beings who will choose the option that derives maximum utility.

The focus of this study relates to decisions at an individual rather than collective level, therefore, collective action theory would not be appropriate. Further, the diffusion theory focuses more on processes of participation yet the main interest here is not on the processes/ stages of participation, rather the decision of participation and welfare effects. Thus, the classical economic theory was best suited to inform household participation in PELIS and the associated income and food security effects from an individual perspective rather than collective dimension. The study narrowed down to the household utility maximization theory which is further discussed in section 2.1.1.

2.2.1 Theory of Household Utility Maximization

The households choice to participate in PELIS can be explained by the household utility maximization theory (Singh *et al.*, 1986) which captures the microeconomic behavior of households' decision-making on production and consumption. The theory assumes that the main objective of a household is resource allocation in a manner that allows for utility maximization.

The assumption is that households participate in a PES program – in this case PELIS – if the derived benefits exceed the total costs of participation. Following literature, these costs may include;

i) The opportunity costs of the program, denoted (C_{Opc}) which may refer to the difference in the returns derived from engaging in PELIS compared to that derived from alternative income generation activities such as agriculture in own plot or off-farm activities

ii) Direct conservation costs (C_{Con}) which include conservation activities such as nursery establishment and planting and woodlot maintenance.

iii) Transaction costs (C_{Tc}) which would cover the participant's expenses for contract establishment (CFA enrolment costs; PELIS registration fees) and maintenance (e.g. travel expenses, meetings and information gathering).

The decision to engage in PES by a household is based on the expected net benefits ($ENCB$) as shown in equation (2.1) which implies that that a household chooses participation if $ENCB \geq 0$ and vice versa.

$$ENCB = (CB_i) - (C_{Opc} + C_{Tc} + C_{Con}) \quad (2.1)$$

Given that participation in PES is non-random, the model can be modified to analyze variations in welfare (utility) between participants and non-participants as measured by income and food security resulting from the program. A major approach to this is the use of treatment effect framework (Neyman, 1990; Rubin, 1974) which lays a basis for analysis of potential outcomes.

2.3 Empirical literature

2.3.1 Participation in PES

The adoption of participatory management practices as a means of improving conservation outcomes is gaining popularity (Mullan & Kontoleon, 2012; Ogada, 2012; Bremer *et al*., 2014; Shrestha & Shrestha, 2017; Sorice *et al*., 2018). Payment for ecosystem services (PES) is one example of such a program which remunerate landowners in monetary or in kind for providing specific ecosystem services (Engel *et al*., 2008). While program design and conservation outcomes are important, sustainability and long-term ecological success of PES is, in part, dependent on benefiting local communities in an equitable way (Bremer *et al*., 2014). Thus, the justification for local people's participation in PES programmes is on a basis that it corrects market failures, increases information symmetry and bridges the conservation gap (Engel *et al.*, 2008; Hejnowicz *et al*.,2014).

Participation in payment for environmental services (PES) entails incorporating multiple players in decision-making and ecosystem service provision, such as landowners or households living near environmental resources (Bremer, 2014: Sorice *et al*., 2018). Participation can range from being informed about decisions and outcomes to having a significant impact on those decisions and consequences (Mbeche, 2017). Besides, PES participation can be distinguished based on a household's level of involvement in a number of activities. These activities include but are not limited to; soil, water and forest conservation practices, attendance of meetings for planning and solutions, monetary contributions, change of agricultural practices, engagement in election of officials and involvement in land allocation for conservation programs (Pagiola *et al*., 2008; Coulibaly-lingani *et al*., 2011; Mullan & Kontoleon, 2012; Zewdu & Beyene, 2018).

Previously, most studies have largely approached and modelled participation as binary choice (Kwayu *et al*., 2014; Okumu & Muchapondwa, 2020a; Persha & Meshack, 2015). While this approach gives some information on participation, it could mask differences in the nature of participation between households, for instance, with regards to wealth classes (Authelet *et al*., 2020; Pagiola *et al*., 2008). However, a few studies outside the Kenyan context have gone further and assessed participation using an index or a set of participation indicators. Pagiola *et al*., (2008) assessed participation in the silvopastoral program in Columbia using indices created from various land use options present in the scheme. These included an environmental services index from 28 different land uses each with a different score, percentage value of farm area converted, and amount of farm area changed for new land use.

In Burkina Faso, involvement in the rolled out forest management program was assessed using 15 indicators condensed into three major participation factors to include: decision making factors (such as attending meetings, involvement in income allocation), forest conservation factors (forest patrols, forest firefighting) and economic factors (forest extraction, fuelwood cutting) (Coulibaly-Lingani *et al*., 2011). In measuring household participation in the Sloping Land Conversion Programme (SLCP), a PES program in China, Mullan & Kontoleon, (2012) used both the binary approach and a participation index computed by measuring the proportion

of total agricultural land entered into the program. In measuring participation, the study went beyond the basic binary choice to create a participation index. The index is more appropriate in identifying variances in participation levels across households of different social classes.

2.3.2 Determinants of participation in PES

Literature on PES participation suggests that participation across socio-economic groups may be dependent on eligibility, desire and ability of households to participate (Bremer *et al*., 2014; Botazzi *et al*., 2018) in addition to other household context characteristics such as gender, age household size and education level. This section reviews empirical literature on determinants participation based on three categories; Program design and structure, gains and benefits from participation, household demographics and socio-economic attributes.

2.3.2.1 Program design and structure

Most PES schemes have a set of minimum entry requirements which households are expected to meet in order to be eligible to participate. While these requirements differ from one scheme to another, the key ones include; proximity to targeted conservation region (Wunder, 2015), membership in community forest associations (Coulibaly-Lingani *et al*., 2011; Okumu & Muchapondwa, 2020a) and land ownership title (if PES requires land use change in private land), formal registration to the PES program or minimum enrollment area (Clements & Milner-Gulland, 2015; Mahanty *et al*., 2013; Okumu & Muchapondwa, 2020a; Pagiola *et al*., 2008). While spatial analysis infers that most poor households are qualified for participation based on proximity criteria, other conditions may lock them out (Bremer *et al*., 2014; Méndez-lópez *et al*., 2019).

Many studies argue that people opt to participate in PES programs on their own volition (Bottazzi *et al*., 2018; Jack & Jayachandran, 2018; Jones *et al*., 2020). However, there is evidence suggesting that PES initiatives may be implemented against the "voluntary" principle. (Mullan & Kontoleon, 2012; Pagiola *et al*., 2008) where administrative influences by governance systems dictates households that participate and those that do not participate. In many programs targeting smallholder

farmers, there may be over subscription and therefore the ultimate decision of who participates in the program depends on selection by the scheme administrators to fill available slots based on slot availability and in some cases a first come -first serve basis (Liu *et al*., 2019; Mullan & Kontoleon, 2012). Thus, whether households participate would be dependent on both household characteristics and administration selection decisions.

The actual design and implementation of a PES program is a complex process that is influenced by a number of factors, including the contextual settings, the resource system and ecosystem services being targeted, the nature and type of actors involved and existing governance systems (Engel *et al*., 2008; Kwayu *et al*., 2014). PES programs in forests are implemented through four main designs which include; 1) Compensation for adoption of sustainable land management practices in own land (such as agroforestry, terracing {*fanya juu/fanya chini*}). Land holders are compensated for the opportunity cost of foregoing more profitable opportunities (Mussa & Mwakaje, 2013; Kwayu *et al*., 2014; Bremer *et al*., 2014); 2) Compensation for avoided deforestation in private forests. This design seeks to increase carbon storage and also achieve biodiversity conservation and farmers are compensated for every hectare retained (Jack & Jayachandran, 2018); 3) Compensation for engagement in afforestation/ reforestation programs in protected areas (Mullan & Kontoleon, 2012; Jack & Jayachandran, 2018); 4) Payment for restoration of deforested government forest land. Compensation can be through gaining user rights in the government protected areas (Clements & Milner-Gulland, 2015; Okumu & Muchapondwa, 2020a). In light of this, households will choose to engage in PES programs that allign with their conservation needs and are within their capital requirements in addition to benefits derived from engaging in the PES program.

2.3.2.2 Gains and benefits from participation

PES programs are in principle assumed to accrue a variety of benefits which are expected to deepen participation of the local communities. For most forest-adjacent households, extraction of timber and non-timber forest products is a major activity. Thus considering the gains, households benefiting from extraction activities have been found to participate more in many PES programs (Persha & Meshack, 2015; Sorice *et*

al., 2018; Bremer *et al*., 2014). However, Adhikari & Agrawal, (2014) show that participation in PES schemes is often lower if the costs incurred in shifting to environmentally acceptable land-use practices by land holders are higher than the benefits derived. In addition, there is an overwhelming evidence that landowners or local populations participating in PES programs may incur higher costs than benefits (Mahanty *et al*., 2013; Mussa & Mwakaje, 2013; Sorice *et al*., 2018) therefore making it less attractive to participate (Wunder, 2015).

Consequently, PES programs whose implementation does not align with the needs and aspirations of communities can dissuade participation (Mbeche, 2017). The implication of this is that PES programs can create contested interests and claims which could affect stakeholders differently. For instance, while the local population interests may be direct use values such as cash benefits derived (Angelsen *et al*., 2014; Mahanty *et al*., 2013), the conservation agencies' intentions would be ecosystem conservation (Authelet *et al*., 2020). Due to these conflicting interests, forest dependent populations may choose not to participate in these schemes (Mbeche, 2017).

2.3.2.3 Demographic and socio-economic attributes

Literature on participation also shows the role of household demographic characteristics such as age, education, household size and gender on participation (Coulibaly-lingani *et al*., 2011; Kwayu *et al*., 2014; Méndez-lópez *et al*., 2019; Okumu & Muchapondwa, 2020a; Shrestha & Shrestha, 2017). The decision and commitment to take part in a conservation program is highly dependent on human capital variables such as age and education level. The role of age is indefinite in that older household heads may have the experience and thus are inclined to participate in conservation programs (Méndez-lópez *et al*., 2019) or they may indicate a higher reluctance in trying new things which is likely to limit their adoption of new conservation technologies (Zbinden & Lee, 2005). Education level is associated with the ability to grasp and process information in addition to enabling implementation of sustainable agricultural practices thus positively influencing participation (Kwayu *et al*., 2014; Shrestha & Shrestha, 2017).

Household size influences participation in conservation programs based on the context of availability of labour and dependence on forest resources to diversify household livelihoods (Coulibaly-lingani *et al*., 2011; Ogada, 2012; Shrestha & Shrestha, 2017). Households with larger families who live near forests rely heavily on forest resources for livelihood diversification because alternative options may be harder to come by. They are therefore more likely to participate in forest conservation activities (Coulibaly-lingani *et al*., 2011; Shrestha & Shrestha, 2017). Gender also plays a significant role in household participation in conservation programs. Male and female households encounter different situations that constrain or foster household participation in PES programs. While women may be involved more in extraction of food products from the forest (Yego *et al*., 2021), their days activities are limited to household chores such as child care, cleaning, food preparation and obtaining home supplies such as fuelwood and water. All these translate to a lack of time for their involvement in other activities such as forest conservation programs (Adhikari & Agrawal, 2014; Coulibaly-Lingani *et al*., 2011; Méndez-lópez *et al*., 2019).

Participation in PES can also be influenced by cultural effects that are context-specific, factors such as social relationships, institutional arrangements, property rights, capabilities, and various capitals (Bremer *et al*., 2014; Okumu & Muchapondwa, 2020a; Sorice *et al*., 2018). Through social networks, such participation is based on enhanced involvement and equal consideration of all stakeholders in the PES program (Bremer *et al*., 2014; Mullan & Kontoleon, 2012). However, empirical analysis on the effect of such dimensions in PES programs remains rare in the literature.

Empirical studies also show that socioeconomic characteristics such as non-farm income and land holding affect household participation in conservation programs (Bremer *et al*., 2014; Clements & Milner-Gulland, 2015; Méndez-lópez *et al*., 2019; Authelet *et al*., 2020; Okumu & Muchapondwa, 2020a;). Households with off-farm income are more likely to participate in conservation programs because it offers the initial financial capital needed to enroll or accommodate anticipated land use changes (Adhikari & Agrawal, 2014; Bremer *et al*., 2014). However, off-farm income could negatively influence participation in PES when household heads perceive less need for

alternative income through involvement in conservation programs (Okumu & Muchapondwa, 2020a).

The requirement to have large land sizes in some programs may be designed to encourage participation among large landowners (Arriagada *et al*., 2015; Clements & Milner-Gulland, 2015). Land holding influences participation in dimensions such as land size and land tenure. In assessing participant heterogeneity in PES programs using a case of China's Sloping Land Conversion Programme (SLCP), Mullan & Kontoleon, (2012) found that households were likely to participate in PES if they perceived their land tenure to be secure. This was expected since secure property rights guarantee any benefits associated with land use changes such as reforestation. In Costa Rica, Bremer *et al*. (2014) assessed determinants of participation in Ecuador's SocioParamo's program and found that approximately a third of all PES participants were wealthy large land owners (enrolling greater than 10 hectares) suggesting that PES programs can be attractive to large land holders. In Kenya, however, (Okumu & Muchapondwa, 2020a), found that participants in the PELIS forestry program, were small landowners who had an interest in more land for cultivation which was covered in allocated forest land.

The aforementioned attributes affect household participation across countries, regions and localities variably and the direction of influence of factors related to household demographic and socioeconomic contexts remains uncertain (Adhikari & Agrawal, 2014). Further, a number of studies have focused on assessing participation solely as a voluntary household decision overlooking the role of administrative influences in household participation (Kosoy *et al*., 2008; Mullan & Kontoleon, 2012). Finally, many studies fail to account for participant heterogeneity, resulting in a skewed image of the nature of participation (Mullan & Kontoleon, 2012; Pagiola *et al*., 2008). As a result, it would be important to analyze how these factors influence participation in a PES forest initiative in Kenya.

2.3.3 Effects of PES on household welfare

There has been a growing interest in the documentation of welfare effects of participation in PES over the last two decades (Arriagada *et al*., 2015; Clements &

Milner-Gulland, 2015; Liu and Kontoleon, 2018; Okumu & Muchapondwa, 2020b). Various studies that have evaluated actual or potential livelihood benefits show that PES is likely to provide livelihood benefits such as increased income levels for households, increased food security, in-kind benefits and capacity building activities (Arriagada *et al*., 2015; Clements & Milner-Gulland, 2015; Kwayu *et al*., 2017; Liu and Kontoleon, 2018; Okumu & Muchapondwa, 2020b).

2.3.3.1 Empirical literature on effects of PES on income

A study by Arriagada *et al*. (2015) examined how landowners' participation in Costa Rica's Program of Payments for Environmental Services (Programa de Pagos por Servicios Ambientales, or PSA) affected their livelihoods. The study targeted 202 respondents, 50 participants and 152 non-participants in PSA in the protected area. Matching was done among the respondents to control the differences that might affect covariate distribution. Findings from the post matching multivariate regression showed no statistically significant difference in welfare since 1996-2005 between the participants and non-participants in the PSA program. However, Bremer *et al*., (2014b) in their study on conservation and livelihood outcomes of a PES program (Socio-Paramo) Ecuadorian Andes, interviewed 45 individuals and 18 communities contracted under the PES program and had completed 1.5 years since enrollment. Findings showed that a majority of the participants reported positive effects of financial capital through either increased or more stable income benefits. Small land holders reported that incentives from the PES program provided substantial income supplements that was used for food, healthcare and education.

Zheng *et al*. (2013) conducted a study on the benefits, costs, and livelihood implications of a regional PES program (Paddy Land to Dry Land-PLDL) in Beijing China. 723 households were surveyed; 394 participants and 329 non-participants. Difference in Difference methods were used to estimate changes in livelihoods due to the program. The results showed that in the PLDL program, both participants and non-participants saw their household income double. However, due to a change from profitable rice paddies to less-lucrative corn fields, PLDL members' agricultural income fell by around 2000yuan ($300) compared to non-participants. However, the

participants' migrant earnings of more than 3000 yuan ($450) compared to non-participants, compensated the reduction in agricultural incomes.

Persha & Meshack, (2015) conducted a study in Tanzania on Joint Forest Management (JFM) to determine its effect on livelihoods, governance and forest conditions. Data was collected from 3363 households across 110 sites in seven regions of Tanzania. The study used a quasi-experimental method with 42 control sites and 68 Joint Forest Management (JFM) sites. Analysis involved the use of a difference-in-difference estimator drawing the baseline data before the implementation of JFM. The findings showed that the initiative does not contribute to an improvement in livelihood incomes or well-being but there are indications of benefit from forest product harvesting. This in part contrasts Matiku *et al*. (2013) whose study in Arabuko-Sokoke Forest, Kenya found that the households in the PFM zones have a higher income than those in non-PFM zones and derive net positive benefit from access of various forest resources. His findings were derived after conducting a cost benefit analysis.

Mugenya (2012) assessed the influence of PES on household wealth and land tenure in Kenya's REDD+ Kasigau corridor. The study used a sample of 250 households, which included both participants and non-participants. Propensity score matching technique was used to estimate differences in livelihood outcomes for the two groups. Findings showed that household income for the PES participants increased by 11.1 percent.

2.3.3.2 Empirical literature on effects of PES on food security

In Northern Cambodia, Clements & Milner-Gulland, (2015) assessed the effect of payments for environmental services and protected areas on local livelihoods and forest conservation. In evaluating well-being and poverty outcomes 769 households were interviewed; 443 within the protected areas, 185 controls and 141 in border villages. The study used impact evaluation methods, quasi-experimental matching and difference-in-difference, to quantify the impact of PES over time on a panel of intervention and matched control households practicing a range of livelihood strategies in villages in the northern forests of Cambodia. Findings showed that households participating in the Ibis Rice and ecotourism programs improved their poverty status

at a greater rate than their non participating counterparts. In addition, non-food secure participants engaged in the Ibis rice program where they increased their harvests and improved food security levels.

Kwayu *et al*. (2017) studied the livelihood effect of the equitable payments for watershed services (EPWS) program in Morogoro, Tanzania. The study involved a sample of 233 households, 116 participants and 117 non-participants. Matching participants and non-participants was done using propensity scores and differences in outcomes were measured using t-test. Findings show that payments from the EPWS program contributed 20 percent of household's annual income. Moreover, crop yields for participants were larger among the treatment group and program participants had improved their ability to meet household food needs in comparison to non-participants. The proportion of participants missing meals, taking little food portions, buying food on credit, offering labour for food and experiencing food constraints was lower among participants than non-participants.

Okumu & Muchapondwa, (2020b) conducted a study on welfare and environmental effects of incentive-based conservation in Kenya. The incentive scheme under study was PELIS in the Mau forest. The study involved data collection from 406 households; 178 non-PELIS beneficiaries and 228 PELIS beneficiaries. Matching methods were used to assess household welfare and forest conditions, while the distributional effects were assessed using a quantile treatment effect model. PELIS participation had a statistically significant impact on household welfare and forest cover, from the findings. However, the program had distributional inequity with positive effect on higher household quantiles thus leaving out the poor households. On the food security dimension, households were allowed to cultivate in allocated forest plots which improved availability and access to food.

Despite the various growing literature on livelihood outcomes, majority of the existing literature focus on income (Mugenya, 2012; Persha & Meshack, 2015; Clements & Milner-Gulland, 2015). The few studies assessing food security effects examine it from a general dimension (of increased harvests/ volumes of food produced) with limited application of empirical models (Clements & Milner-Gulland, 2015; Okumu & Muchapondwa, 2020b). Besides, there is little utilization of internationally

recognized and validated food security metrics such as Food Insecurity Experience Scale (FIES) and Household Dietary Diversity Score (HDDS) in these estimations. In addition, the majority of the studies assess income outcomes broadly, reporting the program's mean effects without disaggregating based on household categories based on income or gender (Zheng *et al*., 2013; Arriagada *et al*., 2015; Kwayu *et al*., 2017). Estimates for mean impact may not present an accurate outcome of the program on income. Thus, it is crucial to assess the distributional impact of the program on household income as a contribution to overall household welfare across different social groups. Nonetheless, few studies have attempted to account for these heterogeneities (Persha & Meshack, 2015; Okumu & Muchapondwa, 2020b). Thus, assessing livelihood outcomes taking into account heterogeneity is crucial to build up literature in this dimension and give a more concise revelation of benefits associated with PES.

The livelihood aspect of food security has received relatively less attention in literature on household welfare and where highlighted, it is done as an outcome from increased income. However, few existing studies shed some light on this dimension. Literature (Clements & Milner-Gulland, 2015; Kwayu *et al*., 2017; Okumu & Muchapondwa, 2020b) reveals that access to ecosystems such as forests and watersheds permits participants to engage in extraction of food products which contributes to food security. However, few studies utilize internationally recognized and validated metrics for measurement of food security such as; Food Insecurity Experience Scale (FIES) and Household Dietary Diversity Score (HDDS). These measures give a better indication of the overall state of household food security considering all dimensions including: access, availability, utilization and stability. Thus, this study expands literature by incorporating the aforementioned measures to assess the impact of PES on food security.

2.4 Research gap

While the body of knowledge on payment for ecosystem services is growing, a bulk of existing research has focused on assessing participation solely as a voluntary household decision overlooking the role of administrative influences. Although households may be eligible and willing to participate in PES programs, they may be locked out due to reasons such as limited program slots or non-selection. Such

occurrences illustrate a variation from the normal voluntary participation which results in the selection bias problem. Further, many studies fail to account for social differences among participants hence giving a biased picture on the nature of participation. Empirical literature reviewed shows limited studies in Kenya on livelihood impacts of participation in PES. Major emphasis is laid on the income dimension of welfare outcomes, yet other facets such as food security are also critical outcomes. Existing studies also reveal gaps in contextual and methodological approaches in the estimation of welfare outcomes which makes comparison and generalization of results difficult. Measurement of outcomes utilizes varying techniques some which could be prone to statistical errors. Moreover, there is still a vacuum in the reporting of welfare implications, with the majority of studies assessing heterogeneous effects reporting conclusions as mean impact. In light of all of this, this research uses counterfactuals to assess the impact of PES on income and food security levels among households. The study further evaluates outcomes of the participants based on their wealth levels and asset endowment as a means of dealing with the issue of heterogeneity among residents.

2.5 Conceptual Framework

This study employs the household utility maximization theory to develop a conceptual framework that explores households' participation, motivations to participate and outcomes of participation in a PES program as implied in Figure 2.1. The framework illustrates how variables under household context interact with costs and benefits, alongside administrative influence to inform participation in PES.

In the framework, household attributes (demographic, socio-economic, institutional and vulnerability) are considered key factors that influence households' participation in PES programs. Demographic attributes such as gender, education, age, household size and occupation are important in a household's decision to enroll or not in this program. Resources and capitals define a household's capacity to undertake land management changes as required in the program.

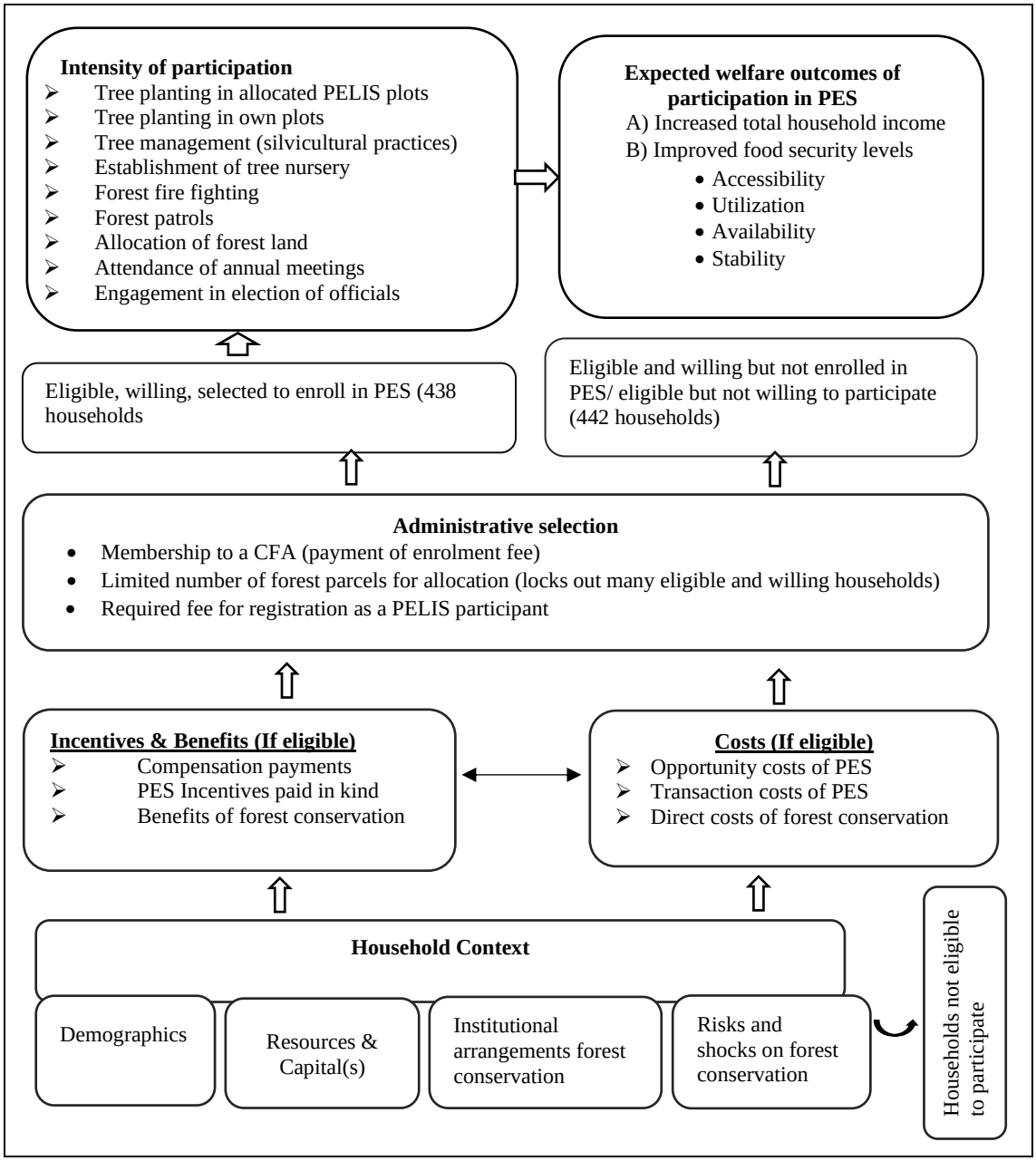

Figure 2.1: Conceptual framework illustrating household participation and livelihood outcomes in PES Source: *Own construct*

Institutional arrangements define who is eligible to participate and the rules and regulations of participating in the program. Risks and shocks associated with participation in forest conservation programs such as human wildlife conflict are also hypothesized to be critical in influencing whether households participate or do not. These household attributes interact with the program's costs and benefits alongside program requirements to enroll for participation. It is hypothesized that households will participate if the costs of participating do not outweigh benefits derived.

On considering the household context and cost benefit analysis, households are open to apply for participation in the program. A set of requirements are in place such as membership to CFA and payment of registration fee for forest land allocation. Nonetheless, due to the limited number of plots available for allocation, a household may be eligible for participation but could get locked out of the program. Selected participants are involved in a number of other forest management complementary activities which define one's intensity of participation. Overall, household participation in PELIS and other associated activities are hypothesized to affect household livelihoods through increased household income and better food security levels.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the research design applied in the study, theoretical framework, empirical framework, measurement of variables, description of study area, population, sampling techniques, data types and sources, data analysis, reliability, validity and ethical considerations.

3.2 Research design

This study employed a quasi-experimental research design in the analysis of the objectives. The study involved groups that had been exposed to treatment (participated in PELIS), comparing them with controls (did not participate in PELIS). This study attempts to establish cause-effect relationship among participation in the PES program and livelihood outcomes such as income and food security using treatment effects models. An alternative to the quasi-experimental research would be the experimental research design. Like quasi experiments, experimental research designs also examine causal effects for certain phenomena. However, experimental research design requires that the phenomena of interest are completely controlled from start to end of study as treatment or control. This study is ex-post, conducting an assessment after the intervention has already been rolled out in Kenyan forests thus making the quasi-experimental design more appropriate. Primary data was collected from households in Mt Elgon forest reserve comprising of both participants and non-participants in the PELIS program. One on one interviews, focus group discussions (FDGs) and key informant interviews (KIIs) were used to collect both qualitative and quantitative data. Data collected included; demographics, socio-economic attributes, institutional factors, farm level attributes and participation in PELIS. Participation was calculated as an index and the determinants estimated using a heck-Poisson model.

3.3 Theoretical framework

This study is based on the household utility maximization theory, previously discussed in detail in chapter two, which assumes that a household allocates resources on production, consumption and labour with the main objective of utility maximization.

This resource allocation is subject to a set of constraints as discussed in section 2.1.1. However, the implication is that household participation decisions only depend on monetary values of the benefits and costs of PES, yet in reality, various non-monetary dimensions influence participation decisions. For example, various household and institutional variables can increase the perceived opportunity costs and risks of the program and hence influence participation. The sum of monetary and non-monetary values can be expressed in in terms of utility. For instance, forest conservation through PES enrolment has a utility function $\mathrm{U(Pes)}$ which depends on the expected net benefits (ENCB), non-monetary values of forest conservation (NMB) and decision by program administrators to enroll households (ADM_D)

$$\mathrm{U(PES)} = (\mathrm{ENCB}, \mathrm{NMB}, \emptyset, \mathrm{Z_h}, \mathrm{ADM_D}) \quad (3.1)$$

Where ENCB depends on expected compensation (CB) and expected participation costs ($\mathrm{C_{Opc}}$, $\mathrm{C_{Con}}$ and $\mathrm{C_{Tc}}$), ϕ represents perceived risk and uncertainties regarding the costs and benefits of conservation and $\mathrm{Z_h}$ is a set of household characteristics that determine how changes in ENCB and NMB are transformed into marginal utilities. For example, the non-monetary value of conservation (NMB), can be higher if a household has a positive attitude towards environmental conservation. In this study, the utility of non-participation in PES is denoted as $\mathrm{U(NonP)}$ which depends on the expected returns from the alternative economic activities (e.g. farming in own agricultural land/ off-farm activities) that the household can engage in ($\mathrm{EB_{Alu}}$), the risk perceptions and uncertainties (ϕ), non-monetary costs and benefits of the agricultural land use (NMA) and the decision by program administrators (ADM_D) to select out certain households due to administrative requirements $\mathrm{Z_h}$ is again included to represent household characteristics that transform $\mathrm{EB_{Alu}}$ and NMA into marginal utilities.

$$\mathrm{U(nonP)} = U_{nonP}(\mathrm{EB}_{Alu}, \mathrm{NMA}, \emptyset, \mathrm{Z_h}, \mathrm{ADM_D}) \quad (3.2)$$

The decision to enroll in the PES program would then depend on a comparison of $\mathrm{U(Pes)}$ and $\mathrm{U(nonP)}$ as underpinned by the random utility model (Greene, 2009) and expressed as;

$$\mathrm{U(PES)}f(\mathrm{ENCB, NMB, \emptyset, Z_h, ADM_D}) \geq \mathrm{U(nonP)}f(\mathrm{EB}_{Alu}, \mathrm{NMA, \emptyset, Z_h, ADM_D}) \quad (3.3)$$

From the above, the probability of participation in PES is a distribution function F estimated as a function of X (a set of household socioeconomic variables, program design and administrative decision, institutional attributes and a vector of risk perceptions and uncertainties). This model can be written as;

$$Prob(D_i = j) = \frac{e^{\beta Xij} + \boldsymbol{\phi}}{e^{\beta Xi0} + e^{\beta Xi1}} \quad \text{where } j = 0,1 \quad (3.4)$$

3.4 Empirical models and specification

3.4.1 Empirical model for assessing households' participation in PES

Literature on participation decisions often considers binary choice of participation or non-participation in a certain program and examine factors influencing a household's decision. However, two major weaknesses of this approach prevent it from being used in this study. First, the choice to participate is not fully dependent on forest households. Although many participants desire to participate, the selected households are only equivalent to the number of forest plots available for allocation. Second, considering a binary choice approach may not adequately capture the nature of participation across participating households. Therefore, this study goes beyond defining participation as a yes or no, to compute an index based on a set of nine PES conservation activities that households are expected to undertake. This approach has been applied in previous studies to estimate participation in conservation programs (Coulibaly-Lingani *et al*., 2011; Pagiola *et al*., 2008). Activities involved include; tree planting in allocated PELIS plot, tree planting in own plot, tree management activities, establishment of tree nursery, forest fire fighting, forest patrols, involvement in allocation of forest land, participation in elections and participation in CFA meetings.

The participation index is calculated using the following formula

$$PI_i = \sum_{i}^{k} \left(Y_{ij} \right) \tag{3.5}$$

Where I_i=Participation index of *i*th household

Y_{ij}= Participation of *i*th household in *j*th activity

The score for the index (Equation 3.5) ranges between zero and nine for the lowest and highest level of participation respectively. A score of zero represents non-participation in PES program which could be due to; (1) an eligible household being unwilling to participate based on its own evaluation of the utility of participation, (2) a household being unable to participate based on resource requirements, (3) an eligible and willing household being crowded out by administrative selection. This study therefore presents a selection bias situation where participating households do not represent a random sample (Schwiebert, 2012).

A heckpoisson model was used to assess determinants of household participation in PES due to its ability to fit outcomes of count data while correcting for sample selection bias in the selection stage. The binary regression approaches applied in similar studies (Kwayu *et al*., 2014; Mussa & Mwakaje, 2013; Okumu & Muchapondwa, 2020a), would not be appropriate in the current analysis since participation in PES is not random. As a measure of robustness, an alternative index was generated from the nine activities using principal component analysis (PCA). Using the index to measure intensity, determinants of participation were estimated using the two-step heckman model which also factors in selection bias and the results are compare with those of heckpoisson model shown in the appendix (Table A3)

The heckpoisson model is estimated in two stage models – the selection and intensity models as in equations 3.6 and 3.7

$$\text{Selection model } S_j = \begin{Bmatrix} 1, \text{ if } X_i^{'}\beta + \varepsilon_{1i} > 0 \\ 0, \text{ if otherwise} \end{Bmatrix}, \tag{3.6}$$

$$\text{Intensity model } P_i = X_i'\beta + \varepsilon_{2i} \tag{3.7}$$

Where: S_j is the binary indicator showing whether the household was enrolled in PES or not

P_i is the participation score illustrating intensity of participation,
X_i' are the explanatory variables hypothesised to influence participation (Table 3.1)
β is a vector of parameters to be estimated
εi is the error term

Equation 3.6 is the selection part of the model and is applied in assessing the determinants of enrolment in the PELIS program. The indicator S is always observable and takes the value 0 or 1 depending on whether the household participated in PELIS or not. Equation 3.7 is the second part of the model, used to assess the factors influencing the intensity of participation in PELIS conditional on whether the household was enrolled or not (the intensity indicator P is only observed if $S = 1$). The indicator for the count outcome y is only observed if $S = 1$. The two equations of the heckpoisson model share predictors which could introduce biases due to high collinearity between the inverse mills ratio (IMR) in the selection model and predictors in the outcome model. In order to overcome this problem, the model was estimated by applying the exclusion restriction approach (ERA) in which one or more predictors in the selection model are excluded in the second stage to reduce bias and yield consistent estimates (Schwiebert, 2012).

3.4.2 Empirical model for assessing effect of participation in PES on household income and food security

Propensity score matching (PSM) (Rosenbaum & Rubin, 1983) and quantile regression model by (Koenker & Bassett, 1978) were used to assess impacts of household participation in PES on incomes and food security. PSM is a nonparametric technique and therefore does not require specification of distribution assumptions. The method compares observed outcomes of participants with those of non-participants by matching observations of the two groups according to predicted propensity of adopting a certain treatment (Rosenbaum & Rubin, 1983). The main attribute of the matching technique is creation of conditions of a randomized experiment in order to evaluate a causal effect as in a controlled experiment.

Given that the surveyed households are either selected to participate in PES or not. Let D_i denote a dummy variable such that $D_i = 1$ if the ith household is enrolled to

participate in PES and $D_i = 0$ if otherwise. Similarly let and Y_{1i} and Y_{0i} denote potential welfare outcomes in the treatment and counterfactual group respectively. The potential welfare outcomes in this study were household income and food security levels. Household income was computed by aggregating income values from all sources (agriculture, PELIS, wage employment, business, forest income and remittances). Household food security was measured using Food Insecurity Experience Scale (FIES) score, Household Dietary Diversity Score (HDDS) and household food consumption expenditure (FCExp).

The first step in PSM was to use a probit model to estimate the propensity scores for each household. The model regressed household participation based on a set of household factors. Using the model, the propensity score, is defined as

$$P(X) \equiv Pr\,(D_i|X) \tag{3.8}$$

Where $P(X)$ is the propensity score, $D = (1)$ indicates the exposure to treatment while X is the multidimensional vector of pre-treatment characteristics.

The next step is matching the households based on the propensity scores. Matching is based on two assumptions. First, is that non-participants provide the same mean outcomes as participants would have provided if they did not participate in the program. This is the assumption of conditional independence. Second is that households with similar X values have a positive probability of P being similar in both participants and non-participants. This is the common support assumption. The condition assumes that some randomness has been achieved to guarantee that households with similar characteristics can be observed in both states (Heckman, 1999).

Once the two assumptions are met, propensity scores can be successfully matched using a suitable matching method. The study used radius matching method to produce best matches. Radius matching is most appropriate when the sample is large. Moreover, it applies the number of comparison units available for a predefined radius thus allowing for use of extra units when good matches are available and fewer units when matches are not available. This reduces the risk of imprecise matches, an

inconsistency that nearest neighbour matching (most commonly used matching method) suffers from.

Finally, the average treatment effect on the treated is estimated by calculating differences between the outcomes of both treated and untreated groups and the difference attributed to the treatment as depicted in equation 3.9

Within cells, treatment exposure is random and is defined by the values of a one-dimensional variable $p(X)$ (Rosenbaum & Rubin, 1983). Given a population *i*, if the propensity $p(X_i)$ is known, the average treatment effect on the treated (ATT) is estimated as

$$ATT \equiv E\,(Y_{1i}|Di = 1) - E(Y_{0i}\,|\,Di = 1) \qquad (3.9)$$

Where $E\,(Y_{1i}|Di = 1)$ is conditional mean of outcome for treated if they participated in the treatment and $E(Y_{0i}\,|\,Di = 1)$ is the conditional mean of outcome for non-treated if they participated in the treatment.

However, general means impacts sometimes do not give a true reflection of scheme impacts, hence, this study sought to examine the distributional effects of participating in PELIS for given quantiles. To achieve this, quantile regression is applied to estimate effects of PELIS for a specific quantile τ in the distribution of total income Y, conditional on a set of covariates X including treatment T (Koenker & Bassett, 1978). The quantile regression model is expressed as

$$Y_i = \beta_\tau X_i + \varepsilon_{\tau i}, Q_\tau\,(Y_i|X_i) = \beta_\tau X_i, \tau \in (0,1), \qquad (3.10)$$

Where $Q_\tau\,(Y_i|X_i)$ represents quantile τ of outcome Y i.e. total household income, dependent on X i.e. household, institutional and demographic variables. Quantiles τ range between values 0 and 1. β represents the coefficients of the covariates in quantiles estimated.

3.5 Model variables used in the study

The description of variables used in the models is done in table 3.1

Table 3.1: Name and description of variables used in the study and their measurement

Variable	Definition and Measurement	Expected sign on participation
Dependent variables		
PES participation	Whether a household is selected for participation or not (1=participant, 0=otherwise)	
Intensity of participation	A index score computed from nine PES conservation activities	
Household context		
Age	Age of household head in years	+/-
Gender	Gender of household head: 1= male	+/-
Household size	Number of members in a household	+
Total income	Aggregated household income (agriculture, wage employment, business, remittances and PELIS)	+
Off farm income/year	Income from non-farm sources in KES	+/-
Food security FIES	Score based on Food insecurity experience scale (FIES) scores 0-8: 0=food secure, 8=Severe food insecurity (FAO-Voices of the Hungry, 2013)	+
HDDS	Score based on Household Dietary Diversity Score: Scores range between 1-12	+
Marital status	Household head married or otherwise: 1=Married	+/-
Annual total household expenditure	Yearly household expenditure in KES	-
Migration status	Native or immigrant: 1=native	+
Education level	Highest level of education attained: 1=primary and below, 2=secondary, 3=tertiary	+
Wealth category	Household wealth group as per wealth index: 1=wealthiest, 2=medium wealth, 3=poorest	+
PELIS plot size	Size of PELIS plot in acres	+
Own farm size	Total land size in acres owned	-
Asset value	Value of all assets owned in KES	+
Number of livestock	Number of livestock owned	+
Livestock ownership	Ownership of livestock by household: 1=yes	+
Extension	Received extension services in the past year: 1=yes	+
Insurance	Received insurance service in the past year: 1=yes	+
Access to credit	Received credit in the past year: 1=yes	+
FUG membership	Member of forest user group (FUG): 1=yes	+
Plot acquisition	Means of acquiring forest plot: 1=allocation by CFA, 0=purchase or renting from owner	+
Risks and costs incurred		
Shocks value	Value of three main shocks suffered by household over the past year in KES	+
Days spent in FUG activities	Average person days spent in FUG activities within 90 days	+
Forest distance	Self-reported distance to nearest forest edge in Km	+
Distance to all weather road	Self-reported distance to the nearest all weather road in Km	-
Distance to market	Self-reported distance to the nearest market in Km	-
Plot payment	Amount paid for allocation of forest land in KES	-
Benefits and incentives for participation in PES		

Share of PES income	Share of PES income as a percentage of total household income	+
Forest extraction	Collection of forest products: 1=yes	+
Expected crop harvests	Crop harvested cited as main reason for participation in PES: 1=yes	+
WTP for conservation	Household willingness to contribute labour or money for forest conservation: 1=yes	+
Own forest or woodlot	Household ownership of private woodlots or forest: 1=yes	+
Perception changes in forest cover	Household's perception of forest cover changes over last 5 years: 1=increased	+

3.6 Data sources and collection

3.6.1 Study Site

The study was conducted in Mt Elgon Forest, Kenya shown in Figure 3.1. Mt Elgon is transboundary, lying between Kenya and Uganda and sits at an elevation of 4321m above sea level. It is located 01^0 07′ 06″ N and 34º 31′ 30″ E about 100 Km north-east of Lake Victoria. The Kenyan side of the ecosystem is located in Bungoma and Trans Nzoia counties which form our study area. The ecosystem is one of the water towers in Kenya and a key water catchment for Lake Victoria, Lake Turkana (Kenya Water Towers Agency, 2018). Mt Elgon has a cool and moist to moderately dry climate and a bimodal rainfall pattern- with an annual rainfall of 1400-1800mm. The main rain seasons are March -May and September-November while the dry seasons run across June-August and December-March. The mean average temperatures range between 14^0C and 24^0 C.

Mount Elgon Forest ecosystem is a biodiversity hotspot of international value. The ecosystem is gazetted as a forest reserve (73705 ha) under management by Kenya Forest Service (KFS), a national park (16916 ha) managed by Kenya Wildlife Service and a nature reserve (17200ha) managed by Bungoma County Government (KEFRI, 2018). Mt Elgon forest is divided into forest blocks that represent the forest administrative units including; Kaberwa, Socio, Kaboywo, Chorlem, and Mt Elgon. Within these forest blocks are smaller administrative units known as forest stations in Mt Elgon forest reserve which include Kaberwa, Kaboywo, Saboti, Sosio, Kimothon and Cheptais (Kenya Water Towers Agency, 2018). These forest stations are managed by KFS officials who monitor access and use of forests by adjacent households. The

livelihood of local people is largely agricultural with about 80 percent of the residents being directly reliant on land through low-input subsistence agriculture or direct extraction of natural resources (Kenya Water Towers Agency, 2018).

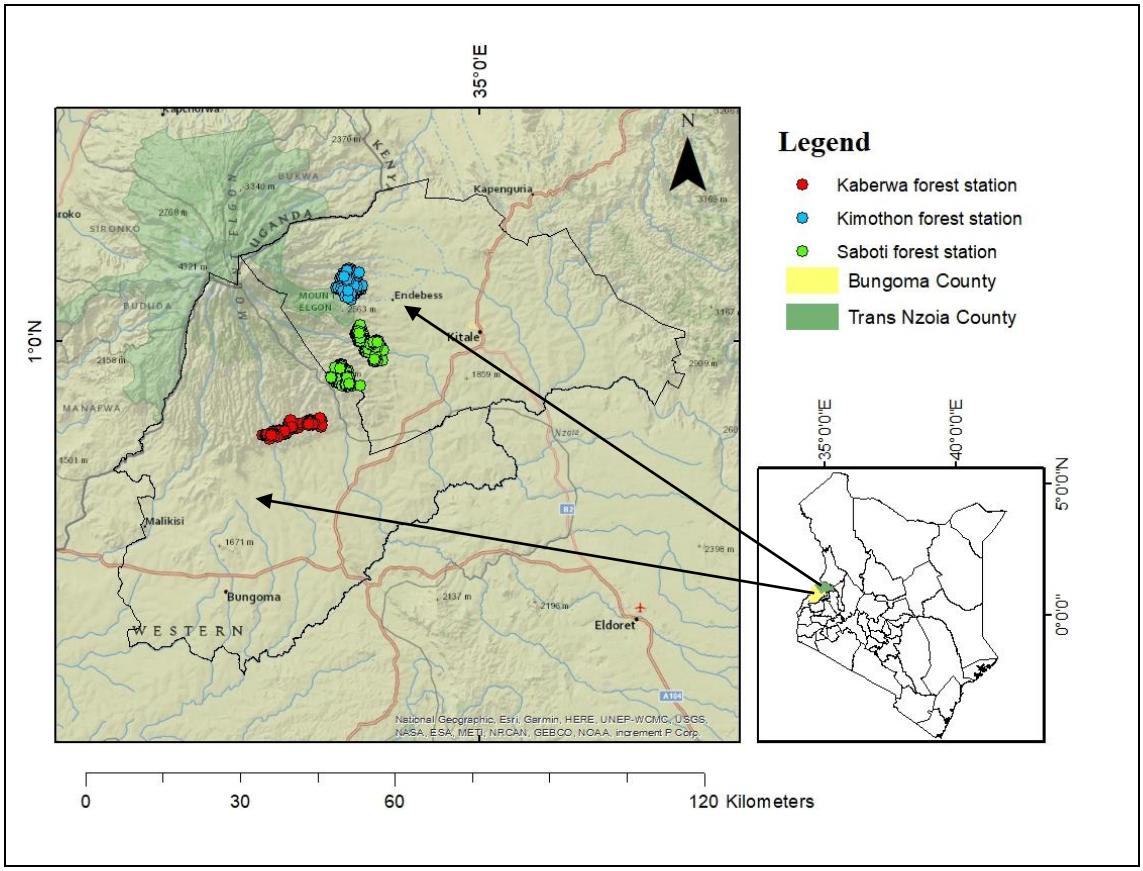

Figure 3.1: Map showing Mount Elgon Forest reserve and surveyed stations

3.6.2 Population and sampling

Data was collected in three forest stations including Kaberwa, Kimothon and Saboti forest stations Interviewed areas in Saboti were located far apart hence their appearance as two distinct groups in the map (shown in Figure 3.1). The three forest stations were selected to represent different administrative areas across Mt Elgon ecosystem and varied proximity to the forest. The regions offer remarkable benefits to the local livelihoods in terms of forest products and other income generating activities (Kenya Water Towers Agency, 2018). Additionally, with the establishment of community forest associations (CFAs), the three forest stations have a long history of involvement in participatory forest management.

The target population were forest dependent communities living 5km around Mt Elgon forest reserve. According to PFM rules of 2015, a household must reside within 5 km radius of the forest boundary for eligibility in community forest associations. The study sought to involve both participants and non-participants in the program. The use of both groups is vital as it gives reliable information on the nature and status of the households if they participated versus if they did not. The first stage involved stratified sampling of three forest stations (Saboti, Kaberwa and Kimothon) from 6 forest stations in the reserve. The stations were considered as stratas since they represent different administrative units and people's variation involvement in forest activities. In addition, they have different proximity to the forest reserve with Kimothon station bordering the national park side while Saboti and Kaberwa stations largely bordering the forest reserve. The second stage involved random sampling of 30 villages in selected forest stations, with probability proportional to village population. Lastly, lists were obtained from village heads and used to randomly select households for the survey proportionate to the population size in each village (more details provided in the appendix, Table A1).

The project area has an estimated population of 35,676 households within the three forest stations selected. This was obtained by getting the sum of all households from the three forest stations as follows; Saboti (8,259), Kimothon (11,396) and Kaberwa (4,567). To determine the sample size, the power sample size estimation formula (Cohen, 2013) was used

$$n = \frac{2(Z_a + Z_{1-\beta})^2 \sigma^2}{\Delta^2}$$

Where n is the required sample size

Z_a, Z is a constant (1.96), $Z_{1-\beta}, Z$ is a constant according to power (90%) of study (1.2816), σ is the estimated standard deviation, Δ is the difference in effect of intervention which is estimated

$$n = \frac{2(1.96 + 1.2816)^2 1.2^2}{0.19^2} = 838$$

However, our study involved a survey of 919 households around Mt Elgon forest. This sample was adjusted to include an additional 10% of the sample size to account for possible household attrition rate.

3.6.3 Data collection

Data collection was done in two phases. First phase involved a detailed qualitative exploration that involved focus group discussions (FDGs) and key informant interviews (KIIs). The objective of this initial phase was to develop a good understanding of the operations of the PELIS program and involvement in other associated activities. In particular, data collected included PES participation procedures, requirements for eligibility in the PES program and additional activities involved on enrolment to PES. 15 FDGs were conducted in August and September 2018, each lasting about two hours. Information obtained from the meetings enabled identification of key indicators and variables that were applied in construction of the final survey tool. Participants of FDGs were local community members identified through assistance from CFA leaders and forest officers. Besides, 10 KIIs with KFS officers, CFA leaders and local government officers were conducted to expand understanding of overall nature of PES in the region and complement data from the survey tool.

The second phase involved administration of the survey questionnaire to household heads of selected households. In their absence, their spouse or any adult member of the household with good understanding of the operations of the PELIS program, agricultural activities and overall household information was interviewed. The survey collected detailed information on participation in the PELIS program as well as on

socioeconomic (e.g. household economic activities, income sources), demographic (e.g. age, gender, household size, education level), institutional (e.g. group membership, access to extension) and farm-level attributes (e.g. land size, crop inputs and outputs). Data collection through questionnaires was done with the assistance of experienced enumerators from the area between November 2018 and January 2019 where 919 households were interviewed.

3.7 Data Analysis

Data analysis involved the computation of the descriptive and inferential statistics. Before analysis data collected was entered into a spreadsheet followed by cleaning to check for any errors or missing observations that could have occurred during entry. Outliers were also checked and corrected from the dataset. The cause of outliers was first determined (whether it is a measurement/ data entry error or population error). In case of a measurement error, the errors were corrected where possible. If not possible to fix, the entry of particular variables was harmonized with the mode value of all other entries. In case of a population error, entries that had unusual properties were removed entirely while those that fit the natural population criteria were retained. Descriptive analysis was done to ascertain the correctness of the dataset for analysis. This involved computation of means, standard deviation, and variances. It also involved generating tables and performing t-tests to determine the statistical significance of mean differences of continuous variables for treated and control groups while z test was used for categorical variables.

The first objective focused on assessing the determinants of intensity of participation in PES among the forest dependent households in Mt Elgon. To achieve this, a heckpoisson regression model was estimated. The second and third objectives were to determine the effect of participation in PES on food security and income levels of forest dependent households in Mt Elgon respectively. Propensity score matching (PSM) method was used to estimate the effect on food security and income. Propensity scores were estimated using the probit model. To guarantee quality matches, the scores were subjected to balancing properties. Score matching was done using radius matching method. ATT was derived using the PSM modeling and t-test was used to

check for statistical significance. To estimate the distributional impacts of income, quantile regression model was applied.

3.8 Ethical consideration

The study kept the responses of the participants confidential and anonymous. This sought to ensure protection of their rights. The data and findings were used only for research purposes.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter summarizes the findings of the study. The first section contains the descriptive statistics used in the analysis. Section 4.3 presents results on the determinants of participation in PELIS while section 4.4 presents findings on the effects of households' participation in PES on food security. Lastly section 4.5 provides a discussion of the results on the effect of household participation in PES on household income.

4.2 Descriptive statistics of sampled households

This section presents summary statistics for variables applied in the analysis of determinants of participation and assess the effect of participation on household welfare. Means and standard deviation of variables were used to show descriptive statistics. Relevant summary statistics for both participants and non-participants are discussed. ANOVA and t-test were used to test for differences between means and frequencies of variables used across the groups. Data were collected from 919 households across three forest stations. In this study context, households were categorized as participants (households allocated PELIS plots by CFA) and non-participants (households that were not allocated PELIS plots). However, there were 39 households with plots not allocated by CFA. The explanation for this is that they obtained PELIS plots through other means such as renting or purchase. Part of the treatment was that one must be a CFA member therefore being non-CFA members with plots, they did not fit as treatment or control hence dropped. 39 such cases were identified as contaminated thus dropped from the sample. Out of the 880 households, 438 (49%) had participated in the PELIS program in Mt Elgon forest region while 442 (51%) had not participated in the program.

Table 4.1 presents the descriptive statistics for continuous variables.

Table 4.1: Descriptive statistics for continuous variables characterizing surveyed households in Mt Elgon

Variables	Whole sample n=880		Participants n=438		Non participants n= 442		
	Mean	Std dev	Mean	Std dev	Mean	Std dev	P-value
Age	46.5	13.7	44.9	12.8	48.1	14.3	0.000
Own land size	2.6	1.9	2.6	1.8	2.7	1.9	0.370
Market distance	3.1	2.8	3.4	3.0	2.8	2.6	0.000
Road distance	14.1	8.4	14.6	8.4	13.6	8.5	0.085
Forest distance	2.6	2.4	2.6	2.3	2.6	2.4	0.922
Household size	6.2	2.2	6.5	2.1	5.9	2.2	0.000
Children	3.2	1.9	3.5	1.9	2.9	1.9	0.000
Food security (FIES) score	4.6	3.2	4.3	3.3	4.9	3.2	0.004
Household dietary diversity score	6.3	1.3	6.4	1.2	6.2	1.3	0.001
Asset value	24425.1	48728.0	24712.3	43777.8	24140.5	53229.9	0.862
Livestock number	9.9	10.3	11.7	11.7	8.1	8.3	0.000
Off-farm income	54611.1	131637.5	48640.9	119332.6	60527.3	142679.3	0.181
Expenditure/year	141551.9	90043.13	147510.1	86316.6	135647.7	93312.4	0.051
Shocks value	30787.4	49761.5	36753.2	54461.4	24875.6	43886.8	0.000
Days spent in FUG activities	1.29	6.0	2.3	7.2	0.3	4.3	0.000
Total income	107751.3	167570.4	116165.5	163997.2	99413.2	170814.2	0.138
Wealth index	0.008	0.9	0.1	1.0	-0.1	0.9	0.000

Children are household members < 18 years.
P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

The overall mean age of sampled households is 46 years which compares well with the findings of 2019 census (Kenya National Bureau of Statistics, 2019). Participants in PELIS were relatively younger (44.9 years) compared to non-participants at 48.12 years. The difference between the two groups is statistically significant at one percent meaning that household heads from the treated group were much younger than their counterparts in the control group. Inclusion of age as a variable in the study is significant since decision-making is an activity intensive in human capital variables such as age. Younger participants imply a higher likelihood to adapt conservation mechanisms which compares with Zbinden & Lee, (2005).

The results also show that the average household size is 6 members, slightly higher than the counties' average of 4.5 persons reported in the national population and

housing census (Kenya National Bureau of Statistics, 2019). Comparatively, participants had more members (six) than non-participants (five) meaning that participating households had relatively higher household sizes compared to non-participants. These results compare to Mugenya, (2012) who also found higher household membership for PES participants in Kasigau Corridor, Kenya. Household size was included in the study as a measure of dependency on forest resources likely to inform the decision to participate in PES programs (Coulibaly-Lingani *et al*., 2011).

Farming (entailing both agricultural and animal production) was the main economic activity for the majority (90.4%) of the household heads. This is consistent with the Counties' development plans that highlight agriculture as a key economic activity in the region (County government of Bungoma, 2018; Trans Nzoia County Government, 2018). The main crop cultivated in the region was maize, both as a cash and subsistence crop. Other crops grown include beans, potatoes, onions and vegetables. On livestock production, results show that on average, surveyed households had nine heads of cattle with participants having more heads (11) compared to non-participants (eight). The difference is statistically significant at one percent implying relatively more cattle ownership among PES participants. Livestock ownership was included in the study as a measure of the role of alternative production activities in influencing participation in conservation practices (Dessart, 2019).

The average farm size for all surveyed households was 2.6 acres which is within range of the reported mean land size of 2.3 acres for Bungoma and 3.7 acres for Trans Nzoia (County government of Bungoma, 2018; Trans Nzoia County Government, 2018). Land sizes do not differ statistically between PES participants and non-participants. Since land is such an important factor of production in rural areas, land-related factors are crucial in the implementation of any conservation strategy (Kisaka & Obi, 2015).

Food Insecurity Experience Scale (FIES) score and household dietary diversity score (HDDS) were computed to estimate households' food security. Food security encompasses four components i.e access, availability, stability and utilization (FAO, 2021). Household dietary diversity Score (HDDS) is a qualitative measure of food consumption that reflects household access and utilization to a variety of foods. FIES indicates the self-reported food-related behaviors and experiences associated with

increasing difficulties in accessing food due to resource constraints. The mean FIES score for participating households was lower than that of non-participants with a statistically significant difference of five percent. The HDDS for participants was higher than that of non-participants and the difference statistically significant at one percent. This observation implies that participants in PES were more food secure compared to non-participating households. These food security measures were key variables in the study considering the design of the program where compensation was largely in kind to allow agricultural production. Hence, a household's food security level was likely to influence their participation in the PES program and consequently the expected outcomes.

The average total annual household income for surveyed households was KES 107751.3 (translates to an average of KES 8979.28/month and KES 289.65/ day (app $2.63/day)) with participants having a higher income than non-participants. While the mean income for all respondents is $2.63[1]/ day, a value above the global poverty line for low income countries of $1.90 /day (World bank, 2018), results show that about 59 percent of surveyed households live below poverty line. This value ($2.63/day) is slightly higher than the national poverty line at KES 3252 ($1.08) per month (Kenya National Bureau of Statistics, 2020) where 42.13% of the households live below poverty line. Household income is a key financial resource hypothesized to influence a household's participation in conservation programs hence its inclusion in the study (Kisaka & Obi, 2015).

Results show that annual household expenditure was KES. 141551.9 ($1286.84) with a mean of KES.147510.1 ($1341) and KES.135647.68 ($1233.16) for PES participants and non-participants respectively. The difference is significant at 10 percent, implying that households participating in the PES program spend slightly more than those who do not. The average value for self-reported shocks was KES 30787.4 ($279.89) with a mean of KES 36753.2 ($334.12) and KES 24875.6 ($226.14) for participants and non-participants respectively. The difference in shocks values between the two groups is statistically significant at one percent asserting that participating households suffered from shocks more than the non-participating households. Inclusion of shocks as a

[1] 1USD =110 KES: Central Bank of Kenya exchange rate)

variable is important in PES participation since it could influence households to join the program as a livelihood safety net or as a way of contributing to reduced climate-related shocks.

Household assets and dwelling characteristics (radio, chair, table, phone, television, bicycle, motorbike, plough, tractor, wooden cart or wheel barrow, pump, and housing characteristics i.e type of dwelling, wall material, roofing material, cooking energy and main water source) were used to compute a wealth index that was used to group the respondents into different wealth classes. The wealthy category comprised of households whose wealth index was above mean value and standard deviation. The middle group included households with a wealth index within the mean and standard deviation. Lastly, households in the poorest group had a wealth index below the mean and standard deviation. The wealth index value computed for all households ranges between -3.008 and 4.139 with an average of 0.008. Participating households had a mean wealth index of 0.105 compared to non-participants with a mean value of -0.115. The average value differs significantly at one percent signifying that participants comprise of relatively wealthier households compared to the non-participants.

The survey assessed average distance to nearest market, all weather road distance and forest distance as proxies for transaction costs. The average distance to the nearest market was 3.1Km with a distance of 2.8Km for non-participants and 3.4Km for participants. The difference is statistically significant indicating that participants were located further from market centers compared to non-participants. A larger distance to the market for participants was likely to make it difficult to access certain commodities hence membership to PELIS would offer an avenue for them to access alternative commodities from the forest. Differences in the distances to the nearest forest edge and all-weather road were not statistically significant between both groups.

Table 4.2 presents statistics for categorical variables used in the study

Results show that a majority of the participants comprised of male household heads (91.1%). There were statistical differences between male and female-headed households suggesting that gender differences could be important in the analysis of participation. Gender is an important inclusion in the analysis to explain rising

disparities (differences among male and female headed households) in PELIS participation and welfare gains (Méndez-lópez *et al*., 2019). Studies in other contexts have also found a higher participation in PES programs among male headed households (Persha & Meshack, 2015; Okumu & Muchapondwa, 2020a).

Table 4.2: Descriptive statistics for categorical variables characterizing surveyed households in Mt Elgon

Categorical variables	Measurement	Entire sample n=880		Participants N=438		Non-Participants N=442		P-value
		N	%	N	%	N	%	
Gender	Male	775	88.1	399	91.1	376	85.1	0.006
	Female	105	11.9	39	8.9	66	14.9	0.006
Education level:	Primary	585	66.5	293	66.9	292	66.1	0.794
	Secondary	270	30.7	138	31.5	132	29.9	0.598
	Tertiary	25	2.8	7	1.6	18	4.1	0.027
Extension access	Yes	460	52.3	263	60.0	197	44.6	0.000
	No	420	47.7	175	40.0	245	55.4	0.000
Occupation	Farming	796	90.5	401	91.5	395	89.4	0.270
	Non-farming	84	9.5	37	8.5	47	10.6	0.270
Credit access	Yes	126	14.3	63	14.4	63	14.3	0.956
	No	754	85.7	375	85.6	379	85.7	0.956
Insurance access	Yes	96	10.9	48	11.0	48	10.9	0.962
	No	784	89.1	390	89.0	394	89.1	0.962
Forest Extraction	Yes	431	49.0	264	60.3	167	37.8	0.000
	No	449	51.0	174	39.7	275	62.2	0.000
Livestock ownership	Yes	772	87.7	404	92.2	368	83.26	0.000
	No	108	12.3	34	7.76	74	16.74	0.000
Farmer group membership	Member	499	56.7	349	79.7	150	33.9	0.000
	Non-member	381	43.3	89	20.3	292	66.1	0.000
Membership to forest user group	Member	465	52.8	438	100	27	6.1	0.000
	Non-member	415	47.2	0	0	415	93.9	0.000
Marital status	Married	780	88.6	402	91.8	378	85.5	0.003
	Otherwise	780	11.4	36	8.2	64	14.5	0.003
Community/ethnicity	Sabaot	684	77.7	358	81.7	326	73.8	0.004
	Other communities	196	22.3	80	18.3	116	26.2	0.004
Migration status	Native	703	80.3	351	80.5	352	80.2	0.905
	Immigrant	172	19.7	85	19.5	87	19.8	0.905
Wealth categories:	Wealthiest	110	12.5	70	16.0	40	9.0	0.002
	Middle wealth	663	75.3	323	73.7	340	76.9	0.275
	Poorest	107	12.2	45	10.3	62	14.0	0.089
WTP for conservation	Willing	651	74.0	321	73.3	330	74.7	0.643
	Not willing	229	26.0	117	26.7	112	25.3	0.643
Ownership of private woodlots	Yes	685	77.8	346	79.0	339	76.7	0.412
	No	195	22.2	92	21.0	103	23.3	0.412
Perception of change in forest cover	Increased	276	31.4	145	33.1	131	29.6	0.268
	Otherwise	604	68.6	293	66.9	311	70.4	0.268

Poorest (Wealth Index ≤ -1), middle wealth (1< Wealth Index < -1), wealthiest (Wealth Index ≥1).

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

With regards to education attainment, majority of households had attained primary education (66.5%) followed by secondary level (30.7%) and tertiary level (2.8%).

There were significant differences in tertiary education attainment between participants and non-participants. Education is a key factor in household decision-making and its inclusion in the study is critical in highlighting any participation and welfare variations across households whose heads have different education levels (Shrestha & Shrestha, 2017).

Slightly over half of the respondents (51.6%) received agricultural extension services within 12 months. A higher proportion of PES participants (60%) had received extension services in comparison to non-participants (44.6%). The difference shows that participants accessed extension services at a higher level compared to non-participants. Higher level of access to extension among participating households would probably be explained by interaction with actors such as forest officials, forest user group leaders who provide extension information on a variety of issues such as silvicultural practices and improved agricultural techniques. This knowledge may be crucial in informing households' adoption of PES practices which could in turn inform households' welfare gains (Coulibaly-Lingani *et al*., 2011).

With regards to extraction of forest products, the results show that about half of the respondents (49%) had extracted forest products during the last 12 months prior to the survey. There were statistically significant differences between participants (60.3%) and non-participants (37.8%) involved in collection of forest commodities. The difference in extraction levels across the two groups was statistically significant at one percent implying that participants were more likely to be involved in extracting forest products. Extraction of forest products allows households to derive cash and non-cash gains through utilization or sale of forest commodities. This is hypothesized to increase the likelihood of household participation in PES and overall positive gains hence inclusion of this variable in the study (Persha & Meshack, 2015).

Results show that slightly over half of the respondents were members of farmer groups (56.7%) and forest user groups (52.8%). A large proportion of participants (79.7%) participated in farmer groups compared to non-participants (33.9%). Farmer groups are formal or informal organizations which can be registered or unregistered. The groups mainly involve members who depend fully or in part on agricultural activities for their livelihoods e.g. farmer field schools, and local community-based

organizations. Membership into farmer groups is likely to be a major catalyst for enrolment into PES programs as most funding organizations prefer to work with already organized groups (Bremer *et al*., 2014).

Study findings show that a majority of households participating in PELIS (81.7%) were members of local indigenous community (Sabaot) compared to (73.8%) of the non-participants. This implies that indigenous groups are more likely to participate in PELIS. The inclusion of this variable is important since it allows for a better understanding on the value that locals hold on the forest ecosystem and whether they would be willing to conserve it through incentive-based programs (Okumu & Muchapondwa, 2020a).

Wealth classification was done using a wealth index computed from a number of owned assets and three categories were derived. The wealthiest category comprised households with a wealth index above the mean value plus standard deviation (≤ -1). The middle category contained households with a wealth index within the range of mean and standard deviation (< -1). Lastly, the poorest households were those with a wealth index below the mean and standard deviation (≥ 1). Membership in the wealthiest category for participants and non-participants differ across the two groups implying a higher membership of the wealthier households to the PES program. Further findings show that a majority of the surveyed households lie in the middle-income group. Categorization of households into different wealth classes is key in establishing a more precise outcome on involvement in conservation programs and distribution of gains across poor and wealthy households (Pagiola *et al*., 2008; Okumu & Muchapondwa, 2020b).

4.3 Determinants of household participation in PELIS in Mt Elgon

The first objective of the study was to assess the levels of participation in PELIS in Mt Elgon, and its determinants. The results of participation and its intensity are presented in Section 4.3.1. later, results on determinants of participation in PES are presented in section 4.3.2.

4.3.1 Participation in PELIS

Participation in PELIS involves a number of activities, key of which was establishing forest plantations on degraded forest plots (logged forest sections that no longer provide desired ecosystem services to people and also to nature) while they cultivate crops and tend to the trees. Crops cultivated in these plots were a benefit to the allocated households as they would either be consumed at home or surplus sold to cater for other household expenses. In addition to establishment of forest plantations, participation in PES encompassed other forest related activities that are presented in table 4.3. The survey results reveal that majority of the participants in PELIS grew maize (73%), beans (14.4%), and potatoes (7.2%) and to a less extent, vegetable crops (5.1%). Participation in PELIS is based on a set of conservation activities as outlined in table 4.3. The highest levels of involvement (above 70%) were in tree planting, attendance of PELIS meetings and participation in silvicultural management activities (Table 4.3). The level of participation was generally low for forest fire fighting (35.6%) and forest patrols (28.1%). These results indicate low levels of participation in activities such as forest patrols and fire fighting. This is contrary to Burkina Faso where households were highly involvement in firebreak maintenance as it was remunerated (Coulibaly-Lingani *et al*., 2011).

Table 4.3: Household involvement in PES conservation activities

PES activity	Frequency	%
Participation in FUG meetings	354	80.8
Tree planting in own plot	346	79.0
Tree management practices	337	76.9
Establishment of tree nursery	304	69.4
Tree planting in PELIS plot	289	65.9
Allocation of forest land	201	45.9
Participation in elections	186	42.3
Forest Fire fighting	156	35.6
Forest patrols	123	28.1

Further, to assess the intensity of participation in PELIS activities, the study used the participation index specified in equation 3.5. The average participation score was 5.3 out of the possible maximum of nine, implying participation in the program was medium. This was obtained through computation of a participation index from the

major PES activities listed in table 4.3. Participation levels based on the participation index were further disaggregated by wealth categories and gender as shown in table 4.4.

Results (see Table 4.4) show that in comparison to female-headed households, male-headed households were more likely to participate in PELIS at greater levels. However, comparatively, female headed households derived higher income from PELIS in comparison to the male headed households but the differences were not statistically significant.

Table 4.4: Comparison of participation scores and household incomes across wealth categories and gender

	Participation score		**PELIS plot (acres)**		**Income from sale of crops in PELIS plots (KES)**		**Share of PELIS income out of total income**	
	Mean	**Std dev**	**Mean**	**Std dev**	**Mean**	**Std dev**	**Mean**	**Std dev**
Full sample N=438	5.3	1.9	1.3	0.9	22242.3	31550.1	29.4%	31.5
Male N=399	5.3	1.9	1.3	0.9	21875.3	29053.3	29.5%	31.5
Female N=39	5.1	1.9	1.1	0.5	25997.4	50897.3	28.5%	32.5
P-value	0.46		0.14		0.44		0.85	
Wealthiest group N=70	5.8	1.9	1.6	1.3	29820.3	37912.8	29.9%	32.5
Middle wealth group N=323	5.2	1.9	1.3	0.9	20889.2	30025.2	28.7%	30.6
Poorest group N=45	5.4	1.9	1.1	0.6	20166.7	30421.7	30.9%	36.6
P-value	0.07		0.02		0.09		0.62	

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

As regards to wealth, wealthier households were more likely to participate at higher levels compared to poorer homes. This could be explained by inability of poorer households to raise resources required for participation. These costs include; enrolment fees (US$15) which accounted for 20 percent of household's monthly income, and other expenses such as cash for inputs and labour.

Participation differed among the three groups with the wealthiest group having the highest participation levels followed by the poorest group while the middle wealth group had the lowest mean participation levels. The results on test of significance from

ANOVA shows a statistically significant difference between intensity of participation across wealth groups suggesting variations in levels of involvement.

Results show that the overall average forestland allocated was 1.3 acres with the wealthiest households having the largest allocations (1.6 acres). The difference in the land sizes across wealth categories was statistically significant suggesting larger allocations for the wealthy. While the program assigns equal plot sizes, probing during interviews revealed that poor households faced challenges financing production activities (buying seed and fertilizer), and therefore informally leased out their allocated parcels to the wealthier households. On average, income from PELIS contributes about a third of the household annual income (KES 22000 or US$ 220) among participating households. Effectively, wealthier households earned more from PELIS plots (KES 29820) compared to the poorest households (KES 20166), a difference of KES 9654 (US$ 96). This difference would in part be attributed to the fact that poorer households had comparatively less resources to support optimal agricultural production which translated to lower returns than wealthier households.

4.3.2 Regression results on determinants of participation in PELIS

A heckpoisson regression model (Poison model with sample selection) was fitted to analyze factors that determine household participation in PELIS. To estimate correlation between the dependent variable and explanatory factors, a multicollinearity test was performed using the Variance Inflation Factor (VIF). Multicollinearity is considered an issue when VIF is greater than 10 (Verbeek, 2012). According to the results in table A2 in the appendix , the model did not have the multicollinearity problem. The VIFs for all components were less than 10, and the mean VIF of 1.14 indicated that the model did not have severe multicollinearity. The model was therefore estimated and the results are presented in Table 4.5.

Table 4.5: Heckpoisson model results on factors influencing participation in PELIS

Variables	Selection model (Participation in PES) Coef.	Std err	P>z	Outcome Model (Intensity of participation) Coef.	Std err	P>z
Household context						
Age	**-0.0109*** **	0.0033	0.001	0.0003	0.0017	0.848
Gender	**0.2957** **	0.1409	0.036	_	_	_
Education level: Secondary	-0.0269	0.0972	0.782	-0.0702	0.0464	0.130
Tertiary	-0.4418	0.2824	0.118	-0.0359	0.1768	0.839
Wealth categories: Middle wealth	**-0.2850** **	0.1378	0.039	**-0.1159** **	0.0571	0.042
Poorest	**-0.4633** **	0.1892	0.014	-0.0643	0.0834	0.441
Own farm size	**-0.0612** **	0.0245	0.013	_	_	_
Livestock ownership	**0.4457*** **	0.1404	0.001	**0.1715** **	0.0876	0.050
Log asset value	0.0392	0.0267	0.141	_		
Log off farm value	**-0.0209** **	0.0084	0.013	_		
Benefits and incentives of participation						
Share of PES income of total income	_	_	_	**0.0017** **	0.0007	0.011
Ownership of Private woodlots	_	_	_	**0.1400*** **	0.0542	0.010
Expected Crops harvests	_	_	_	**-0.1180** **	0.0481	0.014
Forest extraction	**0.5343*** **	0.0898	0.000	0.0556	0.0466	0.233
Perception change in forest cover	_	_	_	**0.0761***	0.0449	0.090
Risks and costs of participation						
No of FUG meetings	_	_	_	**0.0070*** **	0.0024	0.004
Forest distance	0.0087	0.0189	0.647			
Log shocks value	_	_	_	0.0042	0.0060	0.483
market distance	_	_	_	-0.0027	0.0081	0.737
Constant	-0.2270	0.4030	0.573	**1.4124*** **	0.1575	0.000
/athrho	-1.7357	0.8477	0.041			
/lnsigma	-3.3746	1.4463	0.020			
rho	-0.9397	0.0991				
sigma	0.0342	0.0495				
Wald test of indep. eqns. (rho = 0): chi2(1) = 4.19 Prob > chi2 = 0.0406						

1% sig = *** 5% sig = ** 10% sig = *.
Primary education is the reference level for education level.
Wealthiest group is the reference level for wealth categories.

Since poisson regression model outcomes are discrete, the use of coefficients to illustrate predicted probability is allowed which explains the discussion using coefficients. The coefficient determines whether a change in a predictor variable makes the event more likely or less likely, in this case, participation. However,

marginal effects were estimated from the heckpoisson model and results are shown in the appendix (Table A4).

The results show that gender, livestock ownership and forest extraction positively influence participation in PELIS. On the other hand, age, lower wealth categories, landsize and offarm value have a negative influence on participation in PELIS. Findings in table 4.5 further show that livestock ownership, income gains, ownership of private woodlots, positive perception of change in forest cover and participation in FUG meetings had a positive influence on intensity of participation in PELIS. On the other hand, households in the poorest and middle wealth categories in comparison to the wealthiest category and those that expected higher crop harvests were likely to have low participation intensity in PES.

The results reveal that while age influences the participation decision, its influence on the intensity of participation is not significant. This means that, compared to older household heads, younger household heads are more likely to enroll in and participate in the PELIS programs. This could in part be because they are more open to new ideas, innovations, and technologies. The results are consistent with the finding is Zbinden and Lee (2005) who found a higher participation in the PES program in Costa Rica among households with younger heads.

The study findings further show that, male headed households were more likely to participate in the PELIS program in comparison to female headed households. Although PELIS program seeks to promote involvement of marginalized groups such as women and poor community members, their participation is still limited (Pagiola *et al*., 2008; Bremer *et al*., 2014). The key reasons for low participation by women rests on fact that they are constrained by reproductive (e.g. child care) and productive roles (e.g. provision of farm labour, food preparation, water and fuelwood collection etc.) and high program costs (CFA registration fees, fee for land allocation and input expenses). Limited access to and control of resources such as land and other productive assets implies that women may lack access to credit to invest in necessary inputs and engage in sustainable management practices especially those that require land use changes (Méndez-lópez *et al*., 2019). Other studies have reported limited participation of women in conservation schemes often as a result of high participation costs

(González & Martin, 2007; Méndez-lópez *et al*., 2019; Liu *et al*., 2019). Secure land tenure is also a requirement for participation in certain PES programs which is likely to explain low involvement among women (Bremer *et al*., 2014).

Results (table 4.5) also show that wealthier households are more likely to participate in PELIS compared to poor households. Participation in PELIS is conditional on paying enrolment and registration fees and meeting various direct costs {membership fee KES 500 (US$5), an annual renewal fee of KES 100 (US$1) and program registration fee of 1500 ($15)} and indirect costs of engaging in PELIS activities (input costs, costs incurred in tree management and involvement in forest meetings). This might explain the higher participation intensity observed among wealthier households compared to the poorer households. Other studies have also shown that poorer households are limited by initial investment costs, lack of access to information and skills, technical capacity and resources needed to meaningfully participate in government sponsored forest incentive programs (Zbinden & Lee, 2005; Clements & Milner-Gulland, 2015; Jack & Jayachandran, 2018).

Consistent with wider literature (Ren *et al*., 2018; Jones *et al*., 2020), the findings also reveal that the influence of household assets on participation is context specific. While livestock ownership had a positive impact on the choice and intensity of PELIS involvement, farm size and off-farm income had a negative impact. In the study area, livestock is a key asset but households face constraints in access to pasture due to among others, diminishing land resource base. Access to grazing rights in the forest might therefore explain the positive influence ownership of livestock has on participation. Equally, access to additional land through allocated forest parcels allows households to increase agricultural output consequently enhancing their livelihoods while also engaging in forest restoration activities. The incentive is expected to be more appealing to households with smaller farm sizes (Okumu & Muchapondwa, 2020a). The negative influence of off-farm income on participation could be explained by the fact that households with high off-farm incomes are likely to face higher opportunity costs of participation and therefore reduce their interest in PELIS. Similarly, households with higher off-farm income are less dependent on forests and

may not attach much importance in enrolment into the program (Okumu & Muchapondwa, 2020a).

The level of forest benefits (amount of income earned from PELIS plots and extraction of forest products) positively influenced household participation in PELIS. This is consistent with literature showing that incentives and benefits from PES would positively affect participation (Adhikari & Agrawal, 2014; Clements & Milner-Gulland, 2015). Conversely, households whose main motivation to participate was additional crop harvests recorded low levels of participation in PELIS. Interviews confirmed that households expecting higher harvests were more likely to spend a larger amount of their time tending to their crops than on PELIS conservation activities. This is in line with Wichelns *et al*. (2016) who found that the desire to gain more benefits may incline some households to allocate more of their resources to agricultural production while having little involvement in conservation activities which would compromise the main goal of attaining better forest conditions.

Furthermore, ownership of forest woodlots and positive perceptions of forest cover change have a positive impact on participation. Woodlot ownership suggests an individual's interest in environmental conservation activities and a value for better forest conditions, a likely prompt for active participation in conservation. Comparable outcomes were reported in Mau forest complex in Kenya where ownership of private woodlots was positively associated with the desire for increased environmental conservation (Okumu & Muchapondwa, 2020a). Households who perceived an increase in forest cover over the past five years were more likely to participate at a higher intensity meaning that they attach value to high forest cover and are willing to engage in forest cover restoration efforts. The observation implies that while households' participation levels may be driven by monetary and in-kind benefits, the desire to ensure a sustainable forest ecosystem can also influence a higher intensity of involvement in PES. Similar findings have been reported in Mexico (Méndez-lópez *et al*., 2019) and Bolivia (Bottazzi *et al*., 2018) suggesting that households' participation in conservation initiatives may be driven by a genuine interest in conservation of natural resources.

4.4 Effects of households' participation in PES on household food security in Mt Elgon

The second objective assessed the effect of participation in PES on household food security in Mt

Elgon, Kenya. The objective was achieved by using propensity score matching (PSM) (Rosenbaum & Rubin, 1983). Three measures of food security were employed including; Household Dietary Diversity Score (HDDS), Food insecurity Experience scale (FIES) and share of household expenditure on food (FCExp). Prior to PSM modelling, the study presented findings on various crops cultivated to indicate crop diversity and utilization where home consumption or would be a pathway informing food security among households. Later, the food security measures applied are discussed and descriptive analysis done using t-test and means to show how they compare between participants and non-participants. Lastly, propensity score results are later presented following each food security measure.

4.4.1 Crops diversity in PELIS plots and households' utilization strategy

Results show that the key crops grown in PELIS plots were maize (73.5%) beans (14.4%), potatoes (7.2%) and vegetables including cabbages, carrot, spring onions, kales and tomatoes (5.1%). Majority of the crops harvested were used for home consumption (87%) which could have implications on food security. The trends in the use of harvested products confirm findings of related studies on use of farm products largely for home consumption (Matiku *et al*., 2013; KEFRI, 2014; Djenontin & Djoudi, 2015).

4.4.2 Food security estimators

4.4.2.1 Household Food Insecurity Experience Scale (FIES)

FIES score is a measure of access of food at household or individual level developed by FAO through Voices of the Hungry (VOH) Project (FAO, 2013). This scale measures severity of food insecurity based on responses to questions on constraints on ability to obtain adequate food. FIES comprises of a set of eight questions majorly focusing on food related behaviours and experiences associated with increasing

difficulties in accessing food due to resource constraints. The main domains captured in the scale include anxiety/ uncertainty, variations in food quantity and variations in food quality. These measures are further used to classify households in classes of food insecurity severity i.e. those that were food secure, mild food insecure, moderately food insecure and severely food insecure.

A variation between participants and non-participants in different food security levels is estimated and shown in Figure 4.1.

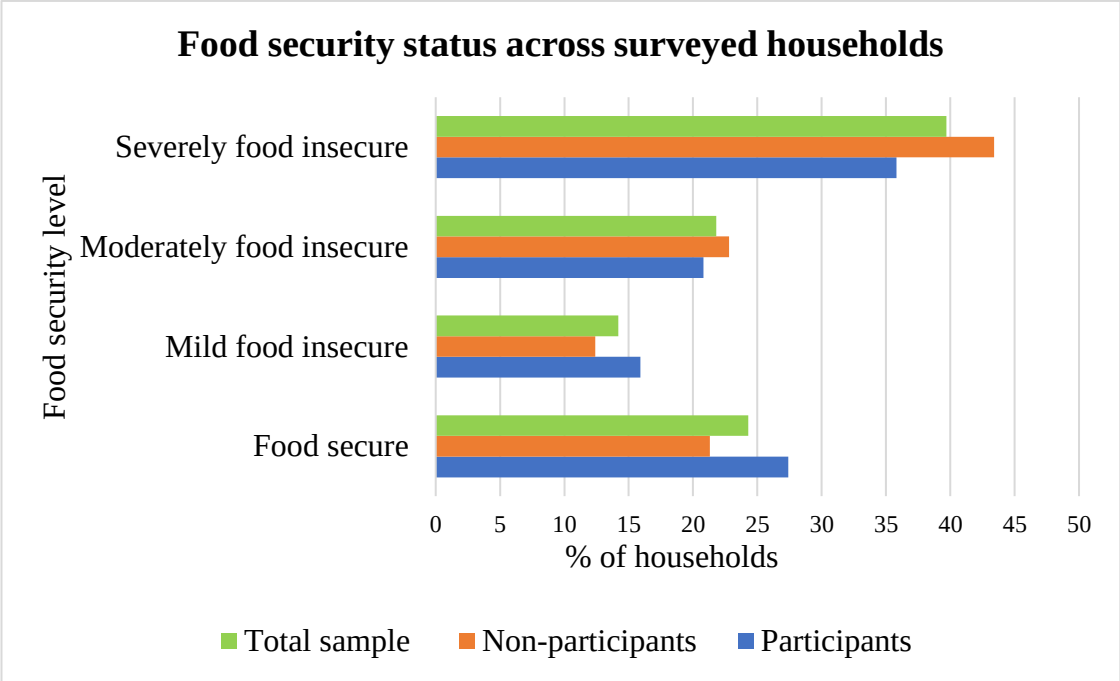

Figure 4.1: Distribution of food security levels across PES participants and non-participants

Results from Figure 4.1 showed that non-participants were more food insecure with a high proportion (43.4%), being severely food insecure. In addition, the number of food secure households was higher among households participating in PES (27.4%) compared to non-participating households (21.3%).

A difference in mean FIES score between participants and non-participants was estimated using independent t-test. Results in Table 4.6 show a statistically significant difference with participants in PES being more food secure in comparison to non-participants.

Table 4.6: Distribution of FIES across surveyed households

	FIES score		
PES participation	**Mean**	**Std dev**	**P-value**
Participants	4.3	3.3	0.004
Non-participants	4.9	3.2	
Total sample	4.6	3.2	

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

Overall, there is relatively high food insecurity among households in Mt Elgon area. This is consistent with the finding on food insecurity in previous national studies which show that households in Bungoma and Trans Nzoia counties are faced with food poverty at 62 and 42 percent respectively (Ministry of Agriculture Livestock Fisheries and Co-operatives (MoALFC), 2021a, 2021b) .

4.4.2.2 Household Dietary Diversity Score (HDDS)

HDDS is a food consumption index that measures a household's access to a diverse range of foods. The HHDS is a 24-hour count of the food groups consumed by a household as described in the FAO guidelines (Kennedy *et al*., 2016). HDDS is designed to give a reflection on economic ability of a household to access variety of foods. Previous literature suggests that an increase in dietary diversity is associated with household food security and socioeconomic status (Adjognon *et al*., 2020).

HDDS was computed by summing all food groups (shown in Table 4.8) consumed results for all surveyed households showed that the highest consumption level was 10 out of 12 food groups. An independent t-test run to compare the mean HDDS between participants and non-participants shows a statistically significant difference as presented in Table 4.7. Non-participants were observed to have consumed fewer food types than their participating counterparts.

Table 4.7: Distribution of HDDS across surveyed households

	HDDS (Number of food groups consumed)				
PES participation	**Mean**	**Std dev**	**Min**	**Max**	**P-value**
Participants	6.44	1.183	4	10	0.000
Non-participants	6.15	1.344	1	9	
Total	6.29	1.274	1	10	

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

Further, a comparison of each food group consumed was done between participants and non-participants and statistical differences estimated using independent t-test. The results are presented in table 4.8

Table 4.8: Food groups consumption across participants and non-participants

Food group consumed	**Total N=880**	**PELIS participant (N=438)**	**PELIS Non-participant (N=442)**	**P-value**
	Freq (%)	**Freq (%)**	**Freq (%)**	
Cereals and derived products	873 (99.2)	433 (98.9)	440 (99.55)	0.250
White roots and tuber plantains	360 (40.9)	178 (40.6)	182 (41.2)	0.871
Vitamin A rich veg dark green leafy veg and other veg	854 (97)	422 (96.3)	432 (97.7)	0.224
Vitamin A rich fruits and other fruits	164 (18.6)	81 (18.5)	83 (18.8)	0.914
Legumes and pulses	569 (64.7)	292 (66.7)	277 (62.7)	0.215
Eggs	47 (5.3)	23 (5.3)	24 (5.4)	0.906
Organ meats and flesh meats	83 (9.4)	42 (9.6)	41 (9.3)	0.874
Fish and sea foods	89 (10.1)	42 (9.6)	47 (10.6)	0.608
Milk and milk products	812 (92.3)	412 (94.1)	400 (90.5)	0.047
Sugar sweets and soft drinks	838 (95.2)	420 (95.9)	418 (94.6)	0.359
Sauces condiments processed foods and snacks	20 (2.3)	10 (2.3)	10 (2.3)	0.984
Fats and oils	835 (94.9)	417 (95.2)	418 (94.6)	0.669

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

Table 4.8 shows consumption of food groups across PES participants and non-participants. While consumption was generally high for cereals and derived products, uptake of nutritious foods including vegetables, milk and milk products and legumes and pulses recorded considerable consumption levels with more than 60 percent of the respondents having consumed the foods over the past 24 hours. Results in table 4.8 only show a statistically significant difference between consumption of milk and milk products for participants and non-participants in Mt Elgon implying limited or no variation in the diversity of foods consumed across both groups.

Further, results show very low consumption (less than 20% of all households) for Vitamin A rich fruits and other fruits, eggs, organ and flesh meats and fish and sea foods. This trend compares with a study by Fraval *et al*. (2019) assessing food access deficiencies among 7708 rural land holders in SSA which showed the most common daily sourced food categories were cereals, tubers, vegetables and legumes with limited consumption of fruits, meats, eggs and fish/sea foods. This was observed owing to the fact that most rural households derive food products from the farm as opposed to the markets. Consumption of meats and eggs was largely observed among households that owned livestock. Limited consumption of fruits, meats, eggs and fish/sea foods results in hidden malnutrition due to deficiency of micronutrients such as zinc, iodine, iron, calcium thus presenting a gap to address food insecurity among rural households.

4.4.2.3 Share of household expenditure on food (FCexp)

Share of household expenditure (as a proxy of income) on food is an indicator of food security where the poorer and more vulnerable a household is, the larger the share of household income spent on food (FAO, 2016; INDDEX project, 2018). If a higher share of total household expenditure is being spent on food, it can result in the household being more resource constrained. The indicator is constructed as follows

$$\frac{Expenditure\ on\ food}{Total\ expenditure} * 100$$

Households are the classified based on their percentage spending on food commodities as vulnerable or food insecure (>75%), high food insecurity (60-74%), medium food insecurity (51-65%) and low food insecurity levels (50% and below) (Smith & Subandoro, 2007). Results in figure 4.2 show the distribution of food consumption expenditure as a share of total income across surveyed households.

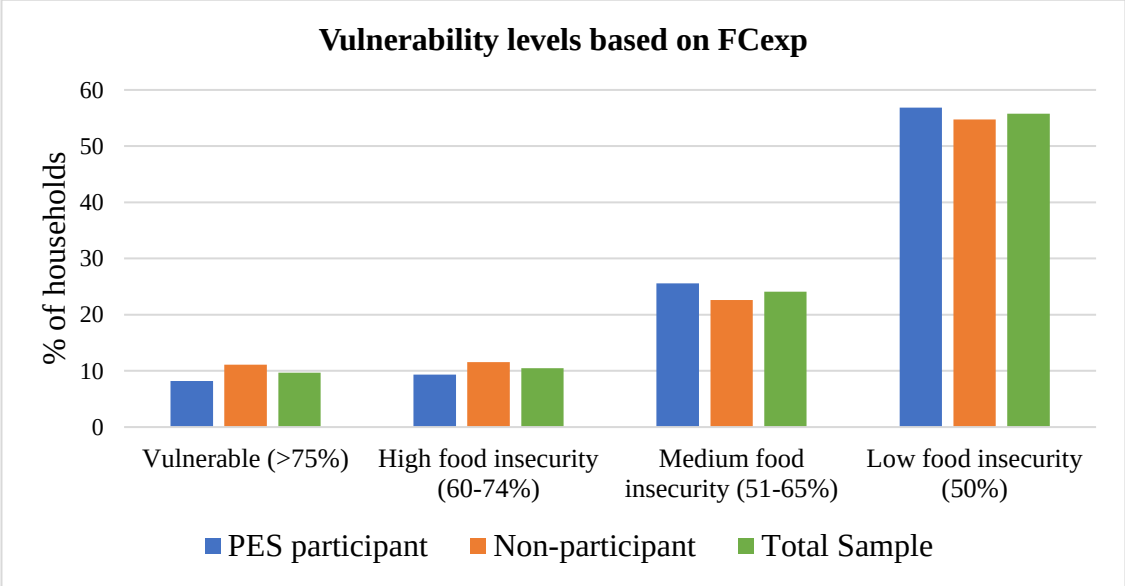

Figure 4.2: Household food security levels based on FCexp

Further, a comparison of the mean share of food consumption expenditure was done between participants and non-participants and statistical differences estimated using independent t-test. The results are presented in table 4.9.

Table 4.9: Share of food consumption expenditure by household participation in PES

	FCexp		
PES participation	**Mean**	**Std dev**	**P-value**
Participants	46.42	19.49	0.253
Non-participants	47.96	20.58	
Total	47.19	20.05	

P-value based on independent t test; 0.01 significance at 1%, 0.05 significance at 5% 0.1 significance at 10%

The results however, do not show any differences between participants and non-participants with both groups have a food expenditure share of between 46 percent and 47 percent which lie in the low food insecurity bracket. This finding would be in part alluded to by the fact that a large proportion of the food produced was consumed at home and the implication possibly be lesser spending on food as opposed to other household necessities.

4.4.3 Average treatment effects on the treated (ATT) for food security

To estimate the effect of participation in PELIS on food security, the study employed propensity score matching (PSM) method. Propensity scores were computed using probit regression model for matching purposes (Table A5-Appendix) with participation in PES (selection and registration to the program) as the treatment variable. After obtaining the propensity scores, matching was done using radius matching method since is most appropriate when the sample is large. Moreover, it applies the number of comparison units available for a predefined radius thus allowing for use of extra units when good matches are available and fewer units when matches are not available. This reduces the risk of imprecise matches.

4.4.3.1 Diagnostic test results

Two tests were performed on the model to check that the overlap criterion was met. The initial step was to create a density distribution of propensity scores. The results, as shown in the Appendix, (Figure A1) reveal that the propensity scores for the treated and control variables overlapped significantly, implying that matching would be successful. Second, a balancing test was performed to determine that the propensity score was an adequate balancing score, with covariates having the same distribution for treatment and control groups at each value of the score. After matching, the results of the balancing test in table (A6) in the appendix reveal no significant differences in the variables. On this basis, estimation of food security effects would be permissible.

The region of common support is (0.085, 0.989) where 827 observations are matched with control observations. The mean propensity score was 0.522 and a standard deviation of 0.265 with five blocks. The number of blocks ensures that the mean propensity score for treated and controls is not different and the balancing property satisfied. The final distribution of treated and controls across blocks are tabulated together with inferior of each block. This distribution is shown in table 4.10. 391 non-participants were matched with 436 participants in the common support of the sample of 827. Observations lacking common support were dropped from the analysis.

Table 4.10: Table showing inferior bound, number of treated and controls for each block

Inferior of block of Pscore	PELIS Non-participants	PELIS participants	Total
0.0851419	119	18	137
0.2	132	50	182
0.4	44	78	122
0.6	70	155	225
0.8	26	135	161
Total	**391**	**436**	**827**

4.4.3.2 PSM results for food security measures

PSM estimation was used to obtain average treatment effects on the treated (ATT) on FIES score, HDDS and FCexp using radius-matching estimator. Results are shown in table 4.11.

Table 4.11: ATT for household participation in PES on food security using FIES

Food security measure	n. treatment	n. control	ATT	Std. Err.	t
FIES score	436	391	-0.437*	0.237	-1.844
HDDS	436	391	0.056	0.098	0.576
FCexp	436	391	-0.272	1.428	-0.190

1% sig = *** 5% sig = ** 10% sig = *.

The ATT value reveals that participation in PES reduces a household's FIES score by 0.437 implying a positive effect on food security. This implies that on average, households that participated in PES reduced their food insecurity experience score by 0.437. In comparison with non-participants, results indicate a higher food security level for PES participants. This observation could be informed by access to more food products through forest extraction and availability of food from forest plots cultivated by PES participating households. The ATT values for HDDS and FCExp also show a positive effect on food security. The statistical differences however, are not statistically significant between participants and non-participants. The main implication is that participation in PES positively affects access and availability of food but does not have any notable effect on quality.

Review of other related studies show varying food security effects from participation in PES programs. In assessing the role of PES in reducing hunger across households in Burkina Faso, Adjognon *et al*., (2020) used food security measures including; food consumption expenditure (FCExp), Household dietary diversity score (HDDS) and food insecurity access scale (FIAS). In line with this study's findings, participation in PES results reduced food insecurity as implied by the food insecurity scale and a higher food expenditure among PES participants but no significant influence on HDDS.

Participation in PES may influence food security in various dimensions i.e. households could derive food products directly from cultivation in degraded lands as they engage in restoration or they could get income which would be used to meet households' food expenses. In Cambodia, participation in the payment for environmental services program showed that households increased agricultural productivity and overall food security. Households that participated in ibis rice program had increased rice harvests and improved food security levels (Clements & Milner-Gulland, 2015). In Mau forest, Kenya households that participated in PELIS were allowed to cultivate crops such as potatoes, vegetables, beans and maize whose harvests were either consumed at home or sold to purchase other food and household products. Nutritional value from consumption of the produce led to increased food security and improved productivity (Okumu & Muchapondwa, 2020b).

In Tanzania, participants in the equitable payments for watershed services benefited from higher yields of crops such as beans and cabbages contributing to higher food security levels. Moreover, findings asserted that program participants had improved their capacity to meet household food needs compared to participants. The proportion of participants exchanging labour for food, limiting meals per day, skipping meals, getting food on credit or reducing meal portions was lower in comparison to non-participants (Kwayu *et al*., 2017). However, in their study on the impact of a joint forest management programme in Tanzania, Persha & Meshack, (2015) did not find notable evidence to suggest increased food security among participants compared to non-participants. This was explained by strict forest by-laws that limited access to forest for extraction of subsistence products and high management costs which outweigh any gains associated with the program.

4.5. Effects of participation in PES on household income in Mt Elgon

The third objective was to assess the effect of household participation in PES on wealth in Mt Elgon, Kenya. Before running the propensity score matching (PSM) estimator, Ordinary Least Squares (OLS) regression model was estimated to give preliminary insights on the effect of PES on a household's income levels (Table A8 in the appendix). Further results on quantile regression
model were presented to show the distributional impacts of PES on income. As stated in section 4.4.2, Propensity scores were computed using a probit model with participation in PES (selection and registration to the program) as the treatment variable

4.5.1 Propensity score matching on household income levels

In PSM, the first step was to fit a binary probit model based on the probability of participation or non-participation in PES. Participation in PES (selection and registration into the PES program) was the treatment variable. Significant differences between PES participants and non-participants are exhibited in Tables 4.1 and 4.2. As a result, the data had to be matched and balanced. This was done by estimating a probit regression for participation and non-participation in PES to generate propensity scores for matching purposes. Output for this is presented in table A6 and figure A1 in the appendix. After obtaining the propensity scores, matching was done using radius matching. Participants and non-participants' propensity scores were compared, and variations in income were attributed to PES participation.

The average annual income for all households was KES 107751, with PES participants earning an average of KES 116165 and PES non-participants KES 99413. PSM was used to estimate the difference in household income between the two groups, and the results for the average treatment effect on the treated (ATT) are reported in Table 4.12

Table 4.12: ATT for household participation in PES on wealth using household income

Matching Estimator	n. treatment	n. control	ATT	Std. Err.	t
Radius	436	423	0.346*	0.185	1.875

1% sig = *** 5% sig = ** 10% sig = *.

Results reveal that ATT has a positive and statistically significant value. This implies that on average, participation in PES increased a household's annual income by 41.3 percent, a contribution of more than a third of total household income. In this analysis, the income was log transformed, as a means to pull outlying data from a positively skewed distribution to make the variable normally distributed (Appendix, Figure A2). When the data is log transformed, interpretation is in such a manner that the coefficients are interpreted in terms of percentage change (Wooldridge, 2015). Thus, this value (41.3 percent) is obtained by getting the ATT's exponential minus one multiplied by 100 to get the percentage impact. In this case, (exp)(0.346)-1)*100=41.3%).

Similar findings were reported by Kwayu *et al.* (2017) on the impact of household income on participants in the payment for equitable watershed services (EWPS) in Morogoro, Tanzania where EWPS payments contributed 20 percent of the participants' annual household income. Mugenya, (2012) also found that households who participated participation in the Kassigau corridor PES project, Kenya, had an income increase of 11.1 percent.

However, Arriagada *et al*., (2015) found that participation in PES showed no significant welfare changes among participants and non-participants in Costa Rica. An explanation for this was that the well-being indicators do not exhaustively measure program outcomes. Besides, payments from participating in PSA did not adequately compensate for reforestation and opportunity costs for landowners in Costa Rica. The landowners who had productive farm activities before the PSA programme suffered a negative impact from engaging in the PES scheme. The program experienced excess demand from landowners, an indication that there were certain associated gains. Thus, while welfare measures may be key in indicating benefits some intangible gains may not be quantified leading to an inference that PES programs do not offer improvement in household wellbeing suggesting a need for further examination on impact of PES on diverse welfare indicators especially intangible gains.

4.5.2 Quantile regression results on effects of PELIS on household income

While results from OLS and PSM imply that participation in PES increases household income for participating households, the observations are based on mean effects which may not give an indication of distributional effects among various classes, in this case, income categories. It is therefore appropriate to establish the distributional effects of participation across various households based on their income levels. Quantile regression is appropriate for this as it allows for observation of effects across entire sample distribution. Results for quantile treatment effects model are shown in table 4.13.

Table 4.13: Quantile treatment effects model estimation results

Dependent variable: Log total income									
Variables	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
PELIS participation	0.71	0.49	0.35	0.19	0.08	0.07	0.15	0.16	0.08
	(0.32)**	(0.18)***	(0.14)**	(0.10)**	(0.11)	(0.10)	(0.11)	(0.12)	(0.15)
Household demographics									
Age	-0.03	-0.02	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.00
	(0.02)	(0.01)***	(0.01)**	(0.00)**	(0.00)	(0.00)*	(0.00)	(0.00)	(0.01)
Gender	-0.75	-0.38	-0.16	-0.13	-0.15	-0.15	-0.07	0.03	-0.03
	(0.52)	(0.27)	(0.20)	(0.17)	(0.17)	(0.15)	(0.15)	(0.17)	(0.21)
Education: Secondary	0.13	0.36	0.32	0.24	0.25	0.22	0.24	0.19	0.15
	(0.26)	(0.16)**	(0.13)**	(0.12)**	(0.11)	(0.10)**	(0.11)**	(0.12)	(0.16)
Tertiary	1.39	1.36	1.28	1.38	1.15	1.17	1.05	0.89	0.75
	(0.99)	(0.50)***	(0.54)**	(0.40)***	(0.35)	(0.28)***	(0.24)***	(0.30)***	(0.33)**
Household size	-0.06	-0.03	-0.05	-0.01	-0.02	-0.02	-0.04	-0.02	0.01
	(0.09)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)*	(0.03)	(0.03)
Community	0.35	-0.15	-0.21	-0.15	-0.12	-0.03	0.03	0.09	0.21
	(0.42)	(0.22)	(0.17)	(0.13)	(0.12)	(0.10)	(0.10)	(0.12)***	(0.14)
Institutional attributes									
Access to extension	1.22	1.02	0.70	0.56	0.51	0.44	0.32	0.31	0.41
	(0.46)**	(0.21)***	(0.14)***	(0.11)***	(0.11)	(0.10)***	(0.09)***	(0.12)***	(0.16)***
Socio-economic variables									
Livestock Ownership	6.71	0.37	0.51	0.46	0.30	0.12	0.20	0.22	0.15
	(2.28)***	(1.33)	(0.28)*	(0.29)	(0.31)	(0.25)	(0.15)***	(0.16)	(0.21)
Asset value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)***	(0.00)***	(0.00)***	(0.00)**	(0.00)***	(0.00)**	(0.00)***
Yearly expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)**	(0.00)***	(0.00)***	(0.00)***	(0.00)**	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Access to credit	0.60	0.08	0.06	0.19	0.32	0.37	0.39	0.31	0.44
	(0.35)**	(0.21)	(0.20)	(0.19)	(0.19)*	(0.16)**	(0.15)***	(0.19)	(0.22)**
Wealth index	0.30	0.31	0.15	0.13	0.09	0.11	0.08	0.08	0.03
	(0.16)**	(0.08)***	(0.07)**	(0.07)**	(0.06)	(0.05)**	(0.06)	(0.18)	(0.07)
Forest related variables									
Forest extraction	0.28	0.17	0.12	0.05	0.00	0.02	0.02	-0.08	-0.08
	(0.31)	(0.16)	(0.15)	(0.12)	(0.12)	(0.02)	(0.11)	(0.11)	(0.13)

Forest distance	-0.08	-0.03	-0.01	0.02	0.03	0.02	0.00	0.00	-0.02
	(0.07)	(0.05)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)	(0.97)	(0.04)
Ownership of private woodlots	0.26	0.14	0.01	-0.03	0.08	0.04	-0.03	0.06	0.07
	(0.42)	(0.26)	(0.18)	(0.14)	(0.13)	(0.13)	(0.11)	(0.11)	(0.16)
Positive perception of forest cover change	-0.17	-0.08	-0.05	-0.08	-0.05	-0.07	-0.07	-0.11	-0.08
	(0.32)	(0.19)	(0.15)	(0.13)	(0.12)	(0.09)	(0.09)	(0.09)	(0.12)
Constant	2.51	9.52	9.79	9.94	10.27	10.71	10.81	10.99	10.96
	(2.78)	(1.39)***	(0.41)***	(0.38)***	(0.40)***	(0.35)***	(0.32)***	(0.34)***	(0.41)***

Standard error in parenthesis *** P<0.001 ** P<0.05 *P<0.10

Quantile regression divides the population into equal groups as specified. In this study, using the *qreg* command in Stata, the sample was divided into 9 equal groups (quantiles also known as fractiles). Specification of the quantiles ranges between 0-1 with 0.5 representing the medium. Therefore, to determine distributional effects of PES on households' incomes, the specification for quantiles was done to generate 9 quantiles *(0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9).* Results for quantile treatment effects model are shown in table 4.13.

Heterogeneous quantile regression results show that for quantiles one to four, the scheme had a considerable positive impact on total household income. These quantiles depict poor forest-dependent households in the region, demonstrating the scheme's distributional inequality. Based on earlier findings, 59 percent of surveyed households live below poverty line, thus this result builds on the findings that PELIS program continues to improve the lives of the forest dependent poor.

This result is similar to Okumu & Muchapondwa, (2020b) who found that participation in the PELIS scheme in Mau forest, Kenya also had distributional inequity on welfare. However, unlike this case, in Mau forest, welfare benefits were skewed towards wealthier households i.e. quantile four to quantile nine. Further analysis showed that the average monthly expenditure implied that all households were below poverty line. This means that although PELIS increased welfare for the poor, the poorest (quantiles 1-3) did not benefit as much as the less poor. Arriagada *et al*., (2015) assessed outcomes of a Costa Rican payment for ecosystem services program and found that the participating in the rolled out PES program did not improve or make participating households worse off. Rather, findings indicate that participants joined the program to secure property rights and contribute to forest conservation.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the research and draws conclusions and policy implications based on the findings. There are also proposals for future research and recommendations.

5.2 Summary

Forests offer vital economic, social and cultural benefits yet they continue to be degraded at a higher rate that other natural ecosystems. Payment for ecosystem services (PES) has been lauded globally as a corrective mechanism to revert the trend while improving forest communities' livelihoods. Despite increased implementation of PES programs, there is a limited understanding of participation and its effects on livelihood outcomes especially in sub-Saharan Africa. Yet, this understanding is crucial as efficient forest governance and ecological restoration is dependent on livelihood gains which can only be attained through local communities' participation.

In order to establish outcomes associated with PES, it is crucial to understand local communities' participation patterns and the livelihood outcomes associated with household involvement in PES programs. This study assessed a PES program rolled out in Mt Elgon, Kenya, Plantation Establishment Livelihood Improvement Scheme (PELIS), whose strategy is to enhance community participation in restoration of forest ecosystems through establishment of plantation forests and in return they are granted forest user rights. The objectives of this study were 1) To assess the determinants of participation in PES among households in Mt Elgon 2) To determine the effects of participation in PES on household food security in Mt Elgon and 3) To evaluate the effects of participation in PES household income in Mt Elgon. Data was collected from 919 households comprising both participants and non-participants in Mt Elgon forest, Kenya. Descriptive statistics were used to provide an understanding of forest dependent households' attributes. A Heck-

Poisson model was used to examine the factors that influence participation in the PELIS program. The participation index was 5.3 out of a possible nine, implying a moderate level of participation. Highest levels of participation were observed among wealthier and male-headed households compared to female headed and poorer households. With regards to the determinants of choice and intensity of participation in PELIS, gender of household head, forest extraction, livestock ownership, ownership of private woodlots, income from PELIS, perception of forest cover changes and involvement in forest user group meetings positively influenced participation and intensity of participation. Age of household head, membership to middle and poorest wealth categories off-farm income and expectation of higher crop harvests negatively influenced participation and intensity of participation

Lastly, estimation by PSM revealed that PELIS participation had a positive influence on food security and household income. Results show that the highest proportion of food products produced in PELIS was consumed at home contributing to better food security levels among participating households in access and availability dimensions. Besides, PSM results revealed that FIES reduced with participation in PES indicating positive contribution to food security. Participation PES increased household income by 41% of total household income. In addition, assessment of distributional impacts revealed that the scheme had significant positive impact on total household income for poorest quantiles (one to four) but no significant effect on quantiles five to nine implying that participation in PELIS most impacted the poorest of forest dependent households. Thus, on the basis of these findings, the study rejects all the null hypotheses and confirms that; 1) Household characteristics (demographic, socio-economic and institutional) affect participation in PES, 2) Participation in PES has a significant effect on household food security and 3) Participation in PES has a significant effect on households income.

5.3 Conclusions and policy implications

The following conclusions emerge based on the findings of the study. First, whilst the PELIS program seeks to promote participation of low-income and other marginalized

members of the community, study findings show higher levels of participation among male headed and wealthier households. This points to disparities in participation and benefit sharing based on household context where the marginalized in the society i.e. study findings show that only 8.9 percent of women and the 10.3 percent of the poor are included in the conservation program. This exclusion would likely be due to participation costs or administrative conditions which calls for greater attention to the pro-poor design of PES programs implemented on forest ecosystems to ensure inclusion of eligible and willing households.

Second, the study reveals that incentives and benefits from PES (such as income gains from PELIS plots and extraction of forest products and food products cultivated and harvested) can promote participation. While some of these incentives are designed to improve livelihoods, if unmonitored, they would result in failure to achieve desired ecological goals. For instance, results show that households whose expected outcome was higher crop harvests depicted low intensity of participation in PES. This, would in the long-term result in incentive incompatibility where households want to generate more gains (food crops) at the expense of tree growing for better forest conditions. The implication therefore, is the need for enforcement mechanisms to ensure high survival rates of trees planted for sustainable restoration efforts.

Lastly, participation in PES improves households' livelihoods through increased incomes and food security. Participating households have a notable alternative source of income and improved food security especially in terms of access and availability compared to their non-participating counterparts. The program has positive income effects on the poorest participants with benefits skewed towards lower quantiles across households. The implication is that integration of forest communities into resource conservation and management with incentives can result in improved household income and food security. These positive outcomes can inform roll-out of similar programs in other ecosystems offering potential for overall rural development.

5.4 Recommendations

Grounded on the major study findings, some recommendations are suggested. First, low participation among women and the poor suggests a need for bodies focused on ecosystem restoration efforts such as Kenya Forest Service (KFS), Ministry of Agriculture, Ministry of Environment and Natural Resources, and Non-Governmental Organizations (local or international) to roll out strategies that reduce program costs and barriers to participation. These mechanisms might include, applying waivers on enrolment and registration fees for poor households and provision of subsidies for production inputs through use of the Green Climate Fund (GCF) by UNFCC for mitigation of climate change in developing countries. Besides, allowing poor households to make in-kind contributions (e.g. through labour) where they are not able to pay in cash would allow participation of cash constrained households.

Second, the varying influence of household capitals point to the importance of taking into consideration gender and other socio-economic contexts when designing and implementing PES programs. These factors have been recognized as an obstacle, which derail the success of rolled out PES programs. KFS and supporting institutions such as CFAs should consider implementing other related programs that are less capital intensive such as protection of threatened ecosystems for direct payments or farm forestry in own land to increase households' engagement levels in forest conservation as they continue to derive desired benefits. Besides, CFA committees (body involved in selection of participants) could purposively sample / screen for the diverse vulnerable groups in study areas to be considered for inclusion in the program if it is to achieve inclusivity over the long term.

Lastly, the scheme can be lauded for being pro-poor and contributing significantly to incomes of the poorest quantiles among forest households. Further, the program improves food security among participating households. These findings affirm the notion that PES contributes to livelihood improvement especially of the vulnerable in the society. A major policy implication could be continued integration of forest dependent communities in

forest management by national bodies such as KFS, KEFRI and international actors such as World Agroforestry (ICRAF). This would be implemented through incentive-based programs as a pathway to increased income, improved food security, reduced poverty and enhanced equality among rural forest dependent households. Rolling out similar pro-poor programs in other forests in Kenya and beyond would be critical in ensuring that poor forest dependent households have better livelihoods and contribute to improved forest conditions.

5.5 Areas for further research

The following areas are identified for further research;

a) The current study used a case of PELIS to understand the effect of PES on welfare outcomes. Future research studies could also conduct an empirical analysis of other PES programs rolled out in forest ecosystems, different from PELIS and their impact on household's livelihoods.

b) The study focused on income and food security livelihood dimensions. Future research could extend this understanding by examining the effect of household participation in PES programs on other household well-being aspects such as general satisfaction, gender inclusivity and collective action.

c) PES is applied in a wide range of ecosystems such as wetlands, rangelands, and game reserves. An investigation of the functioning of PES programs in various ecosystems besides forests i.e. roll out of various PES programs, who participate, how they participate and limitations or hindrances to their involvement would be informative and contribute to the body of knowledge in PES research.

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APPENDICES

Appendix I: Tables and Figures

Table A1 Distribution of sampled households by forest stations

County	Sub-County	Forest station (Stratas)	Villages sampled (sub-stratas)	Population	Sampled number
Bungoma	Mt Elgon	Kaberwa	Chebware Kaberwa town Kamuneru Kaprong Kapsogisho Kipyeto Koshok	4567	226
Trans Nzoia	Saboti	Saboti	Embakasi Gituamba Kaboywo Kaburetwa Kiminini Matisi Misemwa Mukua Murumo Sikinwa Bondeni Teldet Uplands	8259	319
	Kwanza	Kimothon	Basale Chemkengen A Chemkengen B Basale B Chepkirot Matumbei Nyakoigwana Pango Salama B Chepkutwek Cheptobet	11396	375
Total					919

Table A2 Results of multicollinearity test for Heckpoisson model on determinants of participation in PELIS

Independent variable	**Variance Inflation Factor (VIF)**
Share of PES income of total income	1.31
Expected crops harvests	1.3
Market distance	1.29
Log asset value	1.24
Log off farm value	1.23
Wealth categories	1.22
Own farm size	1.1
Age	1.1
Forest extraction	1.08
Log shocks value	1.08
Forest distance	1.07
Livestock ownership	1.07
Education level	1.07
Perception change in forest cover	1.07
Gender	1.06
No of FUG meetings	1.04
Ownership of private woodlots	1.02
Mean VIF	**1.14**

*A VIF < 10 implies absence of the multicollinearity problem.
Source: own computation from survey data (2018-2019)

Table A3 Marginal effects for Heckman model results on factors affecting participation in PELIS

Variables	**Selection model (Participation in PES)**			**Outcome model (Intensity of participation using PCA index)**		
	dy/dx	**Std error**	**P>z**	**dy/dx**	**Std error**	**P>z**
Household context						
Age	-0.004	0.001	0.001	0.008	0.005	0.078
Gender	0.107	0.051	0.036	_	_	_
Education level: Secondary	-0.010	0.035	0.782	-0.118	0.110	0.281
Tertiary	-0.159	0.096	0.098	0.304	0.409	0.457
Wealth categories: Middle wealth	-0.104	0.049	0.035	-0.163	0.166	0.327
Poorest	-0.169	0.068	0.013	-0.059	0.244	0.809
Own farm size	-0.022	0.009	0.012	_	_	_
Livestock ownership	0.162	0.050	0.001	-0.218	0.230	0.342

Log asset value	0.014	0.010	0.141	_	_	_
Log off farm value	-0.007	0.003	0.016	_	_	_
Benefits and incentives of participation						
Share of PES income of total income	_	_	_	0.002	0.002	0.251
Ownership of Private woodlots	_	_	_	0.262	0.111	0.018
Expected Crops harvests	_	_	_	0.409	0.103	0.000
Forest extraction	0.195	0.031	0.000	_	_	_
Perception change in forest cover	_	_	_	0.147	0.099	0.138
Risks and costs of participation						
No of FUG meetings	_	_	_	0.021	0.006	0.001
Forest distance	0.003	0.007	0.701	_	_	_
Log shocks value	_	_	_	0.005	0.013	0.708
Market distance	_	_	_	0.015	0.017	0.376

Table A4 Marginal effects for Heckpoisson model results on factors affecting participation in PELIS

Marginal effects for heckpoisson results on factors affecting participation in PELIS						
Variables	**Selection model (Participation in PES)**			**Outcome model (Intensity of participation**		
	dy/dx	**Std error**	**P>z**	**dy/dx**	**Std error**	**P>z**
Household context						
Age	-0.004	0.004	0.269	0.002	0.009	0.849
Gender	0.108	0.079	0.174	_	_	_
Education level: Secondary	-0.009	0.036	0.783	-0.357	0.233	0.126
Tertiary	-0.158	0.094	0.094	-0.186	0.898	0.836
Wealth categories: Middle wealth	-0.104	0.049	0.035	-0.619	0.314	0.049
Poorest	-0.169	0.068	0.013	-0.352	0.451	0.440
Own farm size	-0.022	0.025	0.371	_	_	_
Livestock ownership	0.162	0.145	0.265	0.883	0.444	0.046
Log asset value	0.014	0.016	0.381	_	_	_
Log off farm value	-0.007	0.007	0.263	_	_	_
Benefits and incentives of participation						
Share of PES income of total income	_	_	_	0.009	0.003	0.009
Ownership of Private woodlots	_	_	_	0.721	0.281	0.010
Expected Crops harvests	_	_	_	-0.608	0.249	0.015
Forest extraction	0.195	0.162	0.231	_	_	_
Perception change in forest cover	_	_	_	0.391	0.232	0.091

Risks and costs of participation						
No of FUG meetings	_	_	_	0.036	0.013	0.004
Forest distance	0.003	0.007	0.632	_	_	_
Log shocks value	_	_	_	0.022	0.031	0.482
Market distance	_	_	_	-0.014	0.042	0.737

Table A5 Output of the probit regression used to derive propensity scores for PSM model

Dependent variable= 1 if household participated in PES and 0 if otherwise			
Independent Variables	**Coefficient**	**Robust Std Errors**	**P-Value**
Age of household head	-0.014	0.004	0.000
Gender	0.203	0.159	0.201
Own land size	-0.014	0.027	0.611
Access to extension 1=yes	0.135	0.103	0.191
Access to credit 1=yes	-0.383	0.143	0.007
Forest extraction	0.462	0.098	0.000
Household size	0.064	0.024	0.009
Forest distance	-0.019	0.021	0.355
Farmers group 1=member	1.258	0.106	0.000
Livestock ownership 1=yes	0.012	0.005	0.029
Log asset value	0.000	0.000	0.599
Log expenditure/year	0.000	0.000	0.936
Migration status 1=Native	-0.032	0.123	0.793
Community/ ethnicity 1= Sabaot	0.295	0.119	0.014
Wealth index	0.139	0.051	0.007
Ownership of private woodlots 1=yes	-0.059	0.118	0.615
Secondary education	-0.334	0.320	0.298
Tertiary education	-0.075	0.108	0.489
Market distance	0.040	0.018	0.025
Occupation 1= Farming	0.253	0.184	0.170
Constant	-1.407	0.387	0.000

Note: Number of observations = 875 Wald Chi square (20) = 207.89 Prob > chi2 = 0.000 ;primary education is the reference level
Source: Own computation from study data (2018/2019)

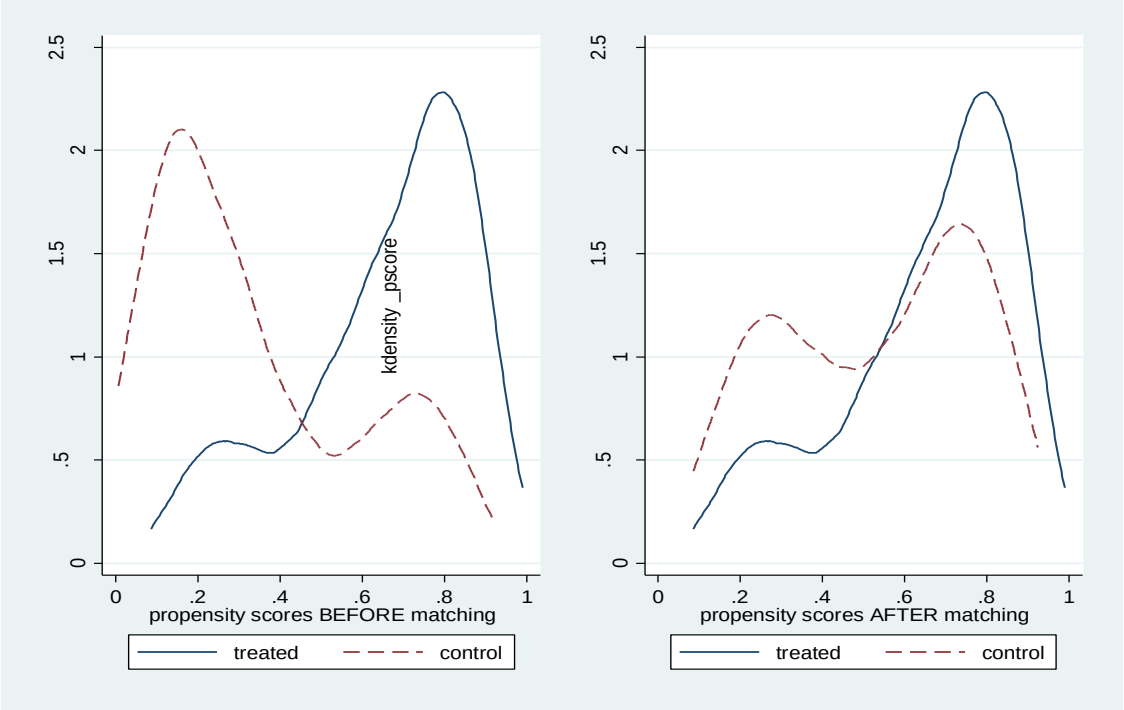


Figure A1: Density distribution of the propensity score for the treated and control variable before and after matching.
Source: Own Computation from Study Data (2018/2019)

Table A6 Balancing test of matched sample for effects of participation in PES on food security and income

Variable	Mean values after covariate matching			Mean values before covariate matching		
	PES participants	**PES non-participants**	**Prob**	**PES participants**	**PES non-participants**	**Prob**
Age of household head	45.279	44.809	**0.591**	44.892	48.124	0.000
Gender 1=Male	0.908	0.922	**0.460**	0.910	0.850	0.006
Own farm size	2.558	2.584	**0.836**	2.586	2.699	0.370
Access to extension 1= Yes	0.603	0.613	**0.764**	0.600	0.446	0.000
Access to credit 1=Yes	0.147	0.153	**0.780**	0.143	0.142	0.956
Extraction of forest products 1=Yes	0.598	0.608	**0.762**	0.602	0.377	0.000
Household size	6.468	6.365	**0.467**	6.461	5.846	0.000
Distance to the forest	2.614	2.652	**0.814**	2.610	2.594	0.922
Farmers group 1=Member	0.792	0.788	**0.892**	0.796	0.339	0.000
No of livestock	11.017	10.798	**0.762**	11.712	8.067	0.000
Asset value	24283.000	25149.000	**0.781**	24712.29	24140.46	0.862

Expenditure per year	150000.000	140000.000	**0.368**	147510.1	135647.7	0.051
Annual shocks value	0.804	0.816	**0.660**	36753.18	24875.57	0.000
Migration status 1=Native	0.811	0.798	**0.648**	0.805	0.802	0.905
Community/ ethnicity 1= Sabaot	0.097	0.078	**0.775**	0.817	0.737	0.004
Ownership of private woodlots 1= Yes	0.792	0.808	**0.550**	0.789	0.766	0.004
Secondary Education	0.017	0.023	**0.475**	0.315	0.298	0.598
Primary Education	0.317	0.334	**0.602**	0.668	0.661	0.794
Market distance	3.329	3.230	**0.638**	3.447	2.770	0.000
Occupation 1= Farming	0.913	0.919	**0.717**	0.923	0.894	0.270

Table A7 Results of multicollinearity test for model on effects of PES on food security and income

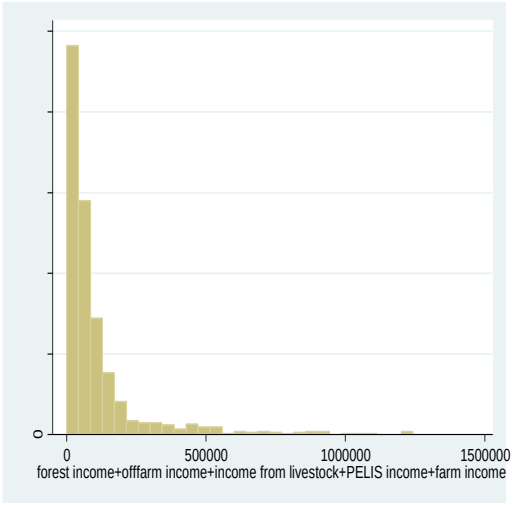
Variable	**VIF**
Farmers group 1=member	1.48
Expenditure/year	1.35
Number of livestock	1.26
Asset value	1.24
Tertiary education	1.2
Occupation 1= Farming	1.2
Access to extension 1=yes	1.18
Household size	1.18
Age of household head	1.15
Access to credit 1=yes	1.14
Wealth index	1.14
Own land size	1.12
Gender of household head	1.11
Forest extraction	1.11
Community/ ethnicity 1= Sabaot	1.09
Secondary education	1.09
Forest distance	1.06
Market distance	1.06
Migration status 1=Native	1.05
Ownership of private woodlots 1=yes	1.02
Mean VIF	**1.17**

Table A8 OLS Estimation Results on Effect of Participation in PES on Total Household Income

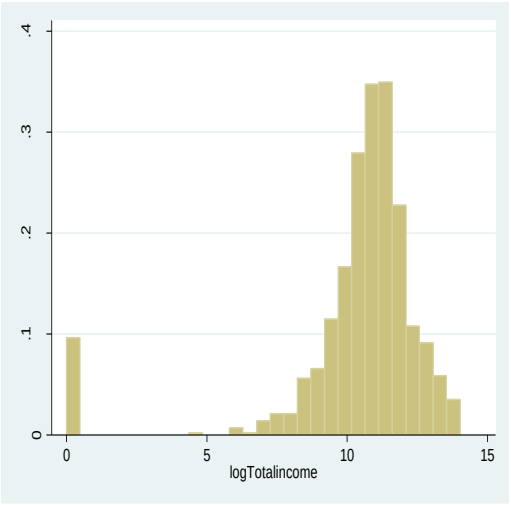
Variables	**Dependent variable: Log total income**		
LogTotal income	**Coefficient**	**Std. Err.**	**P>t**
Participation in PES	0.284	0.172	0.099
Household demographics			
Age household head	-0.025	0.006	0.000
Gender of household head	-0.384	0.265	0.148
Education level: Secondary	0.248	0.184	0.179
Education level: Tertiary	0.703	0.535	0.189
Household size	-0.045	0.040	0.264
Occupation 1=Farming	-1.019	0.303	0.001
Community	-0.143	0.202	0.480
Institutional attributes			
Access to extension	0.859	0.177	0.000
Socio-economic attributes			
Livestock ownership	0.924	0.263	0.000
Asset value	0.000	0.000	0.028
Yearly expenditure	0.000	0.000	0.001
Access to credit	0.319	0.245	0.194
Wealth index	0.168	0.086	0.050
Shocks value	0.000	0.000	0.049
Forest related variables			
Forest distance	-0.008	0.035	0.828
Ownership of private woodlots	0.180	0.198	0.363
Positive perception of forest cover change	-0.197	0.179	0.272
Constant	10.901	0.595	0.000

Note: Primary education is the reference level for education.
1% sig=*** 5% sig=** 10% sig=*

The OLS results show that participation in PES had a positive and significant impact on total household income. Participation in PES increased household income by 32.84 percent, all other factors held constant.



Histogram showing distribution of total income



Histogram showing distribution of logtotal income

Figure A2: Figure showing distribution of total income and log total income variables

Appendix II: Research questionnaire

SECTION 0. INTRODUCTION AND INFORMED CONSENT	
WE ARE FROM THE JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY. TOGETHER WITH RESEARCHERS FROM GERMANY, WE ARE DOING A SURVEY TO UNDERSTAND THE EFFECTS OF MARKET BASED INCENTIVES ON FOREST CONSERVATION AND DEVELOPMENT IN RURAL AREAS OF KENYA. THE DATA COLLECTED WILL BE USED TO UNDERSTAND WHAT COULD BE DONE TO IMPROVE FOREST CONSERVATION AND FOREST DEPENDENT LIVELIHOODS. THE RESULTS AND RECOMMENDATIONS WILL BE SHARED WITH DECISION-MAKERS, WITH COMMUNITY REPRESENTATIVES AND WITH OTHER RESEARCHERS. THE INTERVIEW WILL TAKE ABOUT 1 HOUR. ALL THE INFORMATION WILL REMAIN ANONYMOUS AND CONFIDENTIAL; YOUR NAME AND THE NAMES OF ANY OTHER PEOPLE YOU MAY MENTION DURING THE INTERVIEW WILL NEVER BE PUBLISHED OR SHARED. IF YOU ACCEPT TO PARTICIPATE IN THE INTERVIEW, YOU CAN DECIDE TO WITHDRAW AT ANY MOMENT.	
DO YOU AGREE TO BE INTERVIEWED? ☐ Yes, permission is given ⇒*Proceed to the next page to* - *assign an ID to the interview* - *record the time* *Then start the interview*	☐ No, permission is not given ⇒*Do the following*: - *Fill in the Household Sampling Log to explain why the interview cannot be conducted.* - *Move on to the next household*
DE1. Data entry: enumerator's name and number DE1a. Name: _____ DE1b. Number: ___ ___	DE2a. Data entry done on (day / month / year): ___ ___ / ___ ___ / 201 ___ DE2a. Data entry done on (day / month / year): ___ ___ / ___ ___ / 201 ___

SECTION 1. HOUSEHOLDS' INTERVIEW INFORMATION HII	
HII1. Forest station number: ___ ___ ___ 1= Kaberwa, 2=Saboti Socio 3= Kimothoon	HII2. Household' s ID number (from label sheet or sticker) ___ ___ ___ ___ ___
HII3. Interviewers' name and number Name: _____ Number: ___ ___	HII4. Supervisors' name and number Name: _____ Number: ___ ___
HII5. Day / month / year of interview ___ ___ / ___ ___ / 201 ___	HII6. Interview area HII6a. County: _____ HII6b. Sub-county: _____ HII6c. Village /Area _____
HII9. GIS Coordinates of the interview location HII9a. Latitude: ___ ___ ___ ___ ___ ___ HII9b. Longitude: ___ ___ ___ ___ ___ ___	HII9d. Was the interview conducted at: ☐ Respondent's residence AND farm / production site ☐ Respondent's residence ☐ Respondent's farm or production site ☐ Other (specify): HII8e. Respondent's phone number (if not available, ask for close family members number or neighbour's number):

1.1 HOUSEHOLD PROFILE

A01 Person Nr	**A02** Name	**A03** What is the relation of (name) to the head of house-hold	**A04** Is (name) male or female?	**A05** How old is (name)?	**A06** Number of years spent in school	**A07** How many months in the last year did (name) live away from home?	**A08** Marital status (for people above 12 years)	**A09** What ethnic group do you belong to...?	**A10** What is the occupation of the household head?
		REL CODES	1. F 0. M	Age in years.	EDU CODES	Number of months.	MARITAL CODES	ETHNIC CODES	OCCUPATION CODES
P1		__	___	__ __	__ __	__ __	__ __		
P2		__ __	___	__ __	__ __	__ __	__ __		
A11	Is your family originally from this village?							1=Yes 0=No	

REL CODES	**MARITAL CODES**	**ETHNIC CODES**	**OCCUPATION CODES**
1. Head of household 2. Spouse / partner 3. Son / daughter 4. Grandchild 5. Sister / brother 6. Father / mother 7 Nephew / niece 8. In-law 9. Grandparent 10. Non-relative	1. Married monogamous 2. Married polygamous 3. Living together / de facto 4. Separated 5. Divorced 6. Widow or widower 7. Never married	1 Sabaot 2 Luhya 3 kikuyu 4 other kalenjins 5 other ethnic group (SPECIFY)	**1**-farming 2-Wage employment 3- business person 4-ecotourism 6- other specify

SECTION 2. LAND RESOURCE BASE

2.0 Land

Do you possess land or use land for agriculture, aquaculture or forestry (This includes land owned, rented in/borrowed in or common land that is accessed for agriculture or forestry)

1= Yes 0= No

If Yes, please report the household's land and the area used for agriculture or forestry (owned and rental in/out) separately for each parcel. Please start with the homestead

BO1 Land Parcel S.No	**B02** Land Area	**B03** Main land use	**B04** Tenure status	**B05** When was the land obtained	**B06** What is the current value of the land if you want to sell (only for owned land)	**B07** Rental rate per year whether rented in or rented out		**B08** Distance from household to the parcel of land		**BO9** Perceived land security
codes	Acres	L/USE CODES	TENURE CODES	YEAR	Value in KSH.	In Cash (KES)	In Kind (KES)	In Km	In minutes	SECURITY CODES
1										
2										
7	Total Land Owned									

8	Total Land Rented out					
9	Total Land Rented in					

LAND USE CODES	**Tenure codes**	**Perceived land security**
1 = Cropland	1=own land (with title)	1 very secure
2= pasture land	2= Owned land (without title)	2 secure
3= agroforestry	3= Rented land	3 moderately secure
4= fallow/ Silvipasture	[someone else's land	4 insecure
5= Other vegetation types/land uses (residential, natural forests plantations	4= allocated forest land	5 Very insecure
	5= Communal land	
	6=Family land	
6= Plantations and crops	7= other (specify)	

SECTION 3.0 FOREST RESOURCE BASE AND DECISION MAKING

3.1: FOREST RESOURCE BASE

CO1	Did you access to the forest in the last 12 months ? If no go to C10						1=Yes 0=No				
CO2	How has access to the forest changed since 2005						1=increased, 2=decreased 3 remained the same				
C03	How far is it from the house/homestead to the edge of the nearest natural or managed forest that you can use						1. Measured in terms of distance (straight line)?				Km
							2. Measured in terms of distance (shortest distance)				Km
							3. Measured in terms of time (shortest time)?				Min
C04	Does your household collect firewood? If 'no', go to C06						0= No; 1=Yes				
C05	How has availability of firewood changed over the past 5 years?						1=declined; 2=about the same; 3=increased				
C06	Has your household planted any woodlots or trees on farm over the past 5 years? *If 'no', go to next section. 0= N0; 1= Yes*										
C07	If yes in C10, what are the reasons for planting these trees?	**Reason**	**Yes**	**No**		**Yes**	**No**	**Please rank the main three**			
		1=Own use (firewood)			5= Sale of timber			**Rank 1**	**Rank 2**		**Rank 3**
		2= own use (timber)			6= Conservation						
		3=Fruit trees			7=Other (specify)						
		4= Sale of firewood									
C08	Did the household clear any own forests or forests on leased land during the past 12 months? If No go to C10							1=yes, 0=no			
C09	If yes	1. How much forest was cleared?						(In acres)			
		2. What was the cleared forest (land)used for? Codes 1.cropping, 2.tree planting, 3.pasture, 4.non agricultural uses 5.regeneration 6. Other (specify) (rank max 3)						**Rank 1**	**Rank 2**	**Rank 3**	
		3.If used for crops which principal crop was grown? (Crop codes) 1=maize 2=beans 3=irish potatoes 4=Matoke 5 other (specify)						**Rank1**	**Rank 2**	**Rank 3**	
		4.If plantation forest, what was the age of the forest?						(Years)			
		5. What was the ownership status of the forest cleared?						1=own forest 2=forest on leased land			
		6. How far from the house was the forest cleared located?						(Km)			
C10	Has the household over the last 5 years clear own forests or forests on leased land (complete removal of forest batch)						*1=yes, 0= No*				
C11.	If yes how much forest (appox) has been cleared. Over the last 5 years? *Note: This should include the area reported in question C08*						(Acres)				
C12	In your opinion, what overall change has occurred on the forest condition/cover in your area over the last 5 years?						1= Major decrease; 2= Minor decrease; 0= No change; 4= Minor increase; 5= Major increase				
C13	Did your household engage in forest extraction activities over the past 1 year e.g collection of vegetables, fuelwood, herbal medicine or hunting?						1= Yes 0=No				

3.2: MEMBERSHIP IN FOREST USER GROUP	**RESPONSE**
Note: The enumerator should first explain what is meant by a FUG, (e.g Community Forest Association or user group)	

D01	Are you or any member of your household a member of a Forest User Group (FUG)? *If 'no go to 11*	0= No 1=Yes		
D02	Did anyone in your household attend the FUG meetings over the last 12 months?	0= No 1=Yes		
D03	If no, what were the reasons for not attending the meetings. Then go to 6	1= Prefer not to attend; 2= The meetings are not useful; 3= I was not aware of the meetings; 4= I do not have time 99= other reason (specify)		
D04	**If 'yes'**: in your household, who normally attends FUG meetings and participates in other FUG activities?	*Codes: 1=only the wife; 2=both, but mainly the wife; 3=both participate about equally; 4=both, but mainly the husband; 5=only the husband; 6=mainly son(s); 7=mainly daughter(s); 8=mainly husband & son(s); 10=mainly wife & daughter(s); 11=other arrangements not described above.*		
D05	How many person days (= full working days) did the household members spend in total on FUG activities (meetings, policing, joint work, etc) over the 3 months?	No of days		
D06	Does your household make any cash payments/contributions to the FUG? If no, go to 7	0= No 1=Yes		
D07	**If 'yes'** how much did you pay in the past 12 months?*(KES)*			
D08	Did your household receive any cash payments from the FUG in the past 12 months? If no go to 9	1=Yes 0= NO		
D09	**If 'yes':** how much did you receive in the past 12 months?*(KES)*			
D10	**What are your reasons for joining the FUG? Please rank the most important reasons, max 3 (Enumerator should allow for spontaneous responses and then probe)** *Reason: 1= increased forest access; 2= Better forest management and more benefits in the future; 3= Access to government support or donor programmes; 4= My duty to protect the forest for the community and future; 5= being regarded as a responsible person in the village 6= social aspect (meeting people, fear of exclusion etc) 7= forced by government etc; 8= Higher prices for forest products; 9= Better quality of forest product; 10= Receipt of direct payments; 11=Makes harvest of forest products more efficient; 12= know forest resources better; 13= Learn new skills; 14= Reduce conflicts over resource; 15 = other (specify)*	**Rank1**	**Rank 2**	**Rank 3**
D11	Overall, how would you say the existence of the FUG has affected the benefits that the household gets from the forest?	*Codes: 1=large negative effect; 2=small negative effect; 3=no effect; 4=small positive effect; 5=large positive effect*		
D12	**If you don't participate in FUG,** why? Please rank the 3 most important reasons CODES: 1=No FUG exists in the village; 2= I'm new in the village; FUG members generally belong to other group(s) (ethnic, political party) that I don't belong to; 3= cannot afford to contribute the time; 4= cannot afford to contribute the cash payment; 5= FUG membership will restrict my use of the forest, and I want to use as I need; 6= I don't believe FUG is very effective in managing the forest; 7= Lack of forest products; 8= Corruption in FUG; 9= Interested in joining but needs more information; 10= FUG exists in village, but household is unaware of its presence; 11= Forest authorities; 12= Other, specify:	**Rank 1**	**Rank 2**	**Rank 3**

3.3 PARTICIPATION IN COMPLEMENTARY PES ACTIVITIES
Now we want to ask you questions concerning your involvement in implementation of complementary CFA activities

Have you been involved in undertaking/ implementing the following CFA activities	**Responses 1=Yes 0=No**
1) Reforestation of degraded forest areas	
2) Tree planting in own farm land	
3) Tree management practices (silvicultural practices)	
4) Nursery establishment	

5)	Forest management committee election	
6)	Forest fire fighting	
7)	Forest patrols	
8)	PELIS land allocation (shamba system)	
9)	Attendance of annual CFA general meetings	

3.4: PLOT ALLOCATION AND PARTICIPATION IN PELIS (PLANTATION ESTABLISHMENT AND LIVELIHOOD IMPROVEMENT SCHEME)

E01 Have you ever participated in the PELIS programme?					1=Yes 0=No							
E02 If No, why (then go to section 4.1)		1= Not aware of PELIS 2=Do not need it 3= Not selected 4= Costs outweigh benefits 5 = Do not like the way program is managed 6=Other (specify										
E03 If yes, when did you first participate					Month and Year							
E04 Are you participating this year (2018)					0=No 1= Yes							
E05 How many plots do you have within the forest?												
E05 Provide plot no.		**E06** How did you acquire each of the plots	**E07** Did you pay to get the plot	**E08** How much did you pay?	**E09** Total allocation (Acres)	**E10** Are you satisfied with your current allocation ?	**E11** If no, how has it affected you?	**E12** What crop (s) are you growing this season	**E13** Which tree species are you growing?	**E14** Who decided which trees to grow	**E15** What benefits do you expect from participating in PELIS
		1=allocated by CFA 2=rented from another person 3=Bought from another person	0=no 1=yes		Total land sizes in acres	0=no 1=yes	1=Did not affect my commitment to the association 2=Failed to participate in some CFA activities 3=Tried to acquire additional plots through leasing 4 =Was absent from CFA meetings 5 =Undermined CFA leadership 6= Other (Specify	1=Maize 2=Maize and beans 3= Tubers 4= Vegetables	1=Cypress 2=Pine 3=Eucalyptus 4= Other (Specify) 5=none	1= Station Forest Officers 2=CFA officials 3=CFA leadership and forest officials 3=Jointly between forest officers and participating households 4=households 5=Other (Specify)	1= Crop harvested 2= Tree Thinning's 3= Non-timber forest products(e.g wild animals, birds, wild honey, fruits, mushrooms) 4= firewood 5= building materials 6 = forest conservation 7=more income 8= social networks 9 = Other (Specify)
plot	**Size**										

3.5 INCOME GAINS : GRAZING

	Is your household involved in grazing in the forest?									1=yes, 0=no		
G01	**G03**	**G04**	**G05**	**G06**	**G07**	**G08**	**G09**	**G10**	**G11**	**G12**	**G13**	**G14**
Do you take the following animals for grazing 1=yes 0=no	**Number of animals taken for grazing**	**How much money do you pay to take the animals to the**	**How much do you pay the herdsperson?**	**Who is responsible for taking the animals to graze (*Codes B*)**	**Average distance from household location to grazing point**	**For how many months did you take the animals for**	**On average, how many times per month do you graze livesto**	**How much time do you spend for this activity per month Hrs/day**	**How much feed would you need for your animals per week?**	**Price per unit**	**Price * quantity**	**Net gain**

			forest for grazing per month?				grazing in the last 12 months	ck in the forest ?	(Incl Walking distance)					
	Response									Qtys	Unit			
Cattle														
Goats														
Sheep														
Donkeys														

Codes B: 1=only/mainly by wife and adult female household members; 2=both adult males and adult females participate about equally; 3=only/mainly by the husband and adult male household members; 4=only/mainly by girls (<15 years); 5=only/mainly by boys (<15 years); 6=only/mainly by children (<15 years), and boys and girls participate about equally; 7=all members of household participate equally; 8=none of the above alternatives

3.6 INCOME FROM FOREST SERVICES

Has the household over the 12 months received any cash or in-kind payments related to the following forest services

Principal purpose	**F01** **1=Yes, 0=No**	**F02** **If yes , what amounts have been received**
1Tourism		
2.Carbon projects		
3.Water catchment projects		
4.Biodiversity conservation		
5.Tree planting		
6.Timber concessions		
7. Others (Specify)		

SECTION 4.1: INCOME FROM AGRICULTURE (PELIS-SHAMBA SYSTEM)

A. Please list the various crops planted and sold **under PELIS programme** and seasons in which they grew(If NOT, go to 4.3)

H01	**H02**	**H03**	**H04**				**H05**	**H06**	**H07**	**H08**	**H09**	**H10**	**H11**		**H12**	
Do you plant the following crop	**Planted on parcel no. (Take land ID from 3.1)**	**Area planted (Size In acres)**	**Planting Seasons**				**Total production**	**Consu Ption**	**Give away**	**Seeds reserved**	**In-kind payments for labor, school fees**	**Animal feed**	**Sale 1 (Sales for season 1)**		**Sale 2 (Sales for season2)**	
			Season 1		**Season 2**											
			Mnth	**Mnth**	**Mnth**	**Month**	Qty	Unit	Qty	Qty	Qty	Qty	Qty	Qty	Price /Unit sold	Qty	Price/ unit sold
Maize																	
Beans																	

Potatoes																	
cabbages																	
Carrots																	
Spring Onions																	
Sorghum																	
Millet																	
Garlic																	
Kales																	
Managu																	
Spinach																	
Cowpea leaves																	
Wheat																	
Sweet potatoes																	
Tomatoes																	
Green peas																	
French beans																	
Other (state)																	

B. COSTS INCURRED IN CROP PRODUCTION UNDER PELIS
Please indicate the various costs related to crop production under the PELIS program

H14	**H15**												
Inputs	**Quantity**												
	Quantity	**Unit**	**Price**	**Total**	**Quantity**	**Unit**	**Price**	**Total**	**Qty**	**Unit**	**Price**	**Total**	
1.Seeds													
2.Fertilisers													
3.**Pesticides**													
Herbicides													
Fungicides													
Insecticides													
4.Manure													
5.Draught power													
6. Hired labour													
Land preparation													
Planting													
Hand weeding													
Fertilizer application													
Pesticide application													
Harvesting/Threshing													
Irrigation													
Family labour													

7.Hired machinery														
Land preparation														
Planting														
Weeding														
Fertilizer application														
Pesticide application														
Harvesting/Threshing														
Irrigation														
8.Transport/marketing														
9.Processing														

4.2. INCOME FROM AGRICULTURE (OTHER PLOTS)

A. In addition to the crops listed above, please list the various crops planted and sold from other parcels of land and seasons in which they grew

H17	**H18**	**H19**	**H20**				**H21**		**H22**	**H23**	**H24**	**H25**	**H26**	**H27**		**H28**	
Do you plant the following crop	**Planted on parcel no.**	**Area planted (Size In acres)**	**Planting Seasons**				**Total production**		**Consu Ption**	**Giveaway**	**Seeds reserved**	**In-kind payments for labor, machine rental,laundry payment, school fees**	**Animal feed**	**Sale 1 (Sales for season 1)**		**Sale 2 (Sales for season2)**	
			Season 1		**Season 2**												
			Mnth	**Mnth**	**Mnth**	**Month**	Qty	Unit	Qty	Qty	Qty	Qty	Qty	Qty	Price/Unit sold	Qty	Price/unit sold
Maize																	
Beans																	
Potatoes																	
cabbages																	
Carrots																	
Spring Onions																	
Sorghum																	
Millet																	
Garlic																	
Kales																	
Managu																	
Spinach																	

Cowpea leaves																	
Wheat																	
Sweet potatoes																	
Tomatoes																	
Green peas																	
French beans																	
Other (state)																	

B. COSTS INCURRED IN CROP PRODUCTION
Please indicate the various costs related to crop production

H29	**H30**												
Inputs	**Quantity**												
	Quantity	**Unit**	**Price**	**Total**	**Quantity**	**Unit**	**Price**	**Total**	**Quantity**	**Unit**	**Price**	**Total**	
1.Seeds													
2.Fertilisers													
3.**Pesticides**													
Herbicides													
Fungicides													
Insecticides													
4.Manure													
5.Draught power													
6. Hired labour													
Land preparation													
Planting													
Hand weeding													
Fertilizer application													
Pesticide application													
Harvesting/Threshing													
Irrigation													
Family labour													
7.Hired machinery													
Land preparation													
Planting													
Weeding													
Fertilizer application													
Pesticide application													
Harvesting/Threshing													
Irrigation													
8.Transport/marketing													
9.Processing													

4.3: OTHER CROP INCOME
Please list any other sources of income that the household derived from their own farm for the period between 11/17 and 11/18

Item			Annual income from own produce/ labour	Weekly consumption of own produce		
H32	**H33**	**H34**	**H35**	**H36**	**H36**	**H37**
	Local unit	Total Annual Harvest	Unit sold /received	Units consumed	Average price per unit	**Place of sale (Market codes)**
Tree crop income						
1Ovacado						
2Oranges						
3Mangoes						
4Bananas						
5 Loquat						
6 Guava						
7 Pawpaw						
8 white supporter						
Woodlot poles						
1						
2						
3						
4						
Herbs						
1						
2						
Honey	Kg					
Charcoal	Kg					
Market codes: **1=local open air market 2=supermarket 3=farm gate 4= Other**						

4.4:A INCOME FROM LIVESTOCK				
H38 Did you keep any of the stocks listed below between 11/17-11/18			0=no 1=yes	
H39 If yes, please list stocks you kept since Nov 2017				
H40		H41	H42	H43
Livestock ID	Animal species/ production activity	Stock at 11/2018	Stock sold during the past 12 months	
				Price/unit
1	Cows			
2	Oxen			
3	Goats			
4	Sheep			
5	Pigs			
6	Donkeys			
7	Chicken			
8	Other (Specify)			

B: LIVESTOCK PRODUCTS					
H44 Did you get livestock products in the last 12 months			0=no , 1=yes		
H45 If yes please list and quantify the products produced during the last 12 months					
H46	**H47**	**H48**	**H48**	**H49**	**H50**
Product ID	**Livestock products**	**Total Production Unit**	**Home use units**	**Quantity sold units**	**Price per unit**
1	Meat (beef/pork/ mutton,chicken)				

2	Milk				
6	Eggs				
7	Hides and skins				
8	Wools				
9	Manure				
10	Draught power				
11	Bee wax				
12	Honey				
13	Curdled milk				
15	Dung				
15	Others				

C. COSTS INCURRED IN LIVESTOCK PRODUCTION Please list the quantities and values of inputs used in livestock production during the last year (11/17-11/18

H51	**H52**															
1.inputs	**Animal 1**				**Animal 2**				**Animal 3**				**Animal 4**			
	Qty	**unit**	**price**	**total**	**Qty**	**unit**	**price**	**total**	**Qty**	**unit**	**price**	**Total**	**Qty**	**unit**	**price**	**total**
1.Feeds/Fodder																
2.Rental of grazing land																
3.Medicines,vaccinations and other veterinary services																
4.Costs of maintaining barns, enclosures, pens, etc																
5. Hired labour																
6.Inputs from own farm																
Other, specify																
TOTAL																

SECTION 4.5: WAGE INCOME

H63 Has any member of the household had paid income in the last year If no proceed to section 4.7 (*Note: One person can be listed more than once for different jobs.)*				**1=yes 0=no**
	H53	H54	H55	H56
1.Household member (PID)	**2.Type of work 1=formal (specify) 2= Casual 3=informal (specify) 4= other**	**3.Do you commute from home village to place of work 1=yes 0=no**	**4.Days worked per month**	**4.Days worked per month**

SECTION 4.6: INCOME FROM OWN BUSINESS (NOT FOREST OR AGRICULTURE)

H57 Are you involved in any type of business?	0=no 1=yes	

H58 If yes, please indicate the income and costs related to that business. *Note: If the household is involved in several different types of business, you should fill in one column for each business.*

	Business1	**Business 2**	**Business 3**
H59. What is your business type [1]			
H60 Gross income (sales)			
COSTS:			
H61 Purchased inputs			
H62 Own- non-labour inputs (Equivalent market value)			
H63 Hired labour			
H64 Transport and marketing costs			
H65 Capital costs (Repair, maintenance, etc)			
H66. Other costs			
H67 Net income (H72-items H73-H78)			

H68 Current value of capital stock			

1) Codes: 1=shop/trade; 2=agric. processing; 3=handicraft; 4=carpentry; 5=other forest based; 6=other skilled labour; 7=transport (car, boat,…); 8=lodging/restaurant; 9=brewing; 10=brick making; 11=landlord/real estate; 12=herbalist/traditional healer/witch doctor; 13=quarrying; 14= contracted work (cleaning/maintenance); 15=renting out equipment; 19=other, specify:

SECTION 4.7: OTHER INCOME SOURCES
Please list any other income that the household has received during the past 12 months.

Type of income		**Total income received in the past year (KES)**
1)	Remittances /Transfer	
2)	Support from government, NGO, organization or similar	
3)	Gifts/support from friends and relatives	
4)	Pension	
5)	Payment for forest services	
6)	Payment for renting out land (if in kind, state the equivalent in cash)	
7)	Compensation from logging or mining company (or similar)	
8)	Payments from FUG	
9)	Other, specify:	

SECTION 4.8: HOUSEHOLD EXPENDITURE
How much did you spend for the following items **Please estimate carefully how much the household spent on each item on a monthly/annual basis**

	S/no.	**ITEM**	**amount consumed over the last 7 days**	**Amount spent per week (Ksh)**	**Amount spent per year**
Food	1	Rice	kg		
	2	Maize/ maize flour	kg		
	3	Millet	kg		
	4	Banana	Kg		
	5	Beans , peas and other pulses			
	6	Milk and milk products			
	7	Bread/Maandazi/Kangumu			
	8	Herbs and spices e.g onions, chilli, ginger			
	9	Roots and tubers e.g potatoes, yam, cassava and their flour			
	10	Fats and oils e.g vegetable/groundnut	litres		
	11	Beef/pork/mutton	kg		
	12	Fish	kg		
	13	Poultry	kg		
	14	Eggs	pieces		
	15	Vegetables	kg		
	16	Fruit	kg		
	17	Food ingredients, spices (include salt/sugar	kg		
	18	Beverages; coffee, cocoa, juice	litre		
	19	Take home and eat out			
	20	Other food			
	21	**Total Food**			
		ITEM	**Amount spent in last 1 month**	**Amount spent in the last 12 months**	
Non	22	Personal care supplies			
	23	Clothes, shoes and bags, accessories			

		ITEM	**AMOUNT SPENT IN THE LAST TWELVE MONTHS**
Education	40	School fees	
	41	Student dress and uniform	
	42	books	
	43	Other cost of schooling	
	44	**Total education**	
Health	45	Medicinal Purchases in pharmacy only	
	46	Doctor fee	
	47	Hospital bills and medicine	
	48	Other health costs	
	49	**Total health including health expenditures later refunded by insurance**	
Social	50	funerals	
	51	Donations (to temples social organizations, schools)	
	52	Recreation and entertainment	
	53	Religious costs	
	54	Lottery	
	55	Transfers and remmitances	
	56	Other gambling expenditures *Sometimes, government officials , police officer or business partners, ask people or expect people to pay a bribe for their service. How much did you have to spend...?*	

	24	Detergent washing powder				57	Bribery/corruption-Police	
	25	hairdresser				58	Bribery/corruption-government police	
	26	Electricity				59	Bribery /corruption-business partner	
	27	Water cost				60	**Total social**	
	28	House rent						
	29	Liquid propane gas/charcoal						
	30	firewood						
	31	waste						
	32	**Total Non-Food**						
	33	Fuel for car and motorbike						
	34	Public transportation						
	35	Telecommunication (airtime and charging)						
	38	Maintenance for car and motorbike						
	39	Insurance and fee for car and motorbike						
		Total transport and communication						

5.1 A: SHOCKS, CRISIS OR UNEXPECTED EXPENDITURES

		S1 Over the past five years, was your household severely affected by any of the following events?	**S2** When did the event occur?		S3 Rank the MAIN THREE shocks experienced according to order of severity	S4 What was the estimated value lost due to this shock?	S5 Did this shock cause a reduction in household income and or assets?	S6 Apart from your HH who else was affected by the event?	S7 Have you suffered from this shock in the past 1 year 1=yes 0=no	S8 Coping activity to deal with the event	
EVENT ID	**Event**	Yes =1 No = 0	Year	Month	CODE B	**Ksh**	Yes =1 No = 0	CODE D		**Major activity**	**2nd activity**
101	Drought										
102	Floods/heavy rains										
103	Crop damage by wild animals										
104	Crop disease or crop pest										
105	Bans (on logging, maize growing etc.										
106	Death of livestock/livestock diseases										
107	Killing of livestock by wild animals										
108	Killing of people by wild animals (hyenas, bee attacks, snake bites)										
109	Trees falling on people or livestock										
110	Livestock theft										
111	Crop theft										

112	Frosts										
113	Erosion/landslides										
114	Fire										
115	Large fall in sale price for crops										
116	Death of household head										
117	Death of working merchant of the HH										
118	Death of other family member										
119	Loss of salaried employment or non-payment of salary										
120	End of regular assistance, aid, or remittances from outside HH										
121	Large rise in price of food										
122	Large rise in agricultural input prices										
123	Severe water shortage										
124	Birth in the household										
125	Break-up of the household										
126	Bread winner jailed										
127	Robbery/buggery/assault										
128	Theft of bicycle, motorcycle or car										
129	Dwelling, damaged, destroyed										
130	Eviction										
131	Ethical/clan clashes										
132	Loss of land										
133	Payment for sale of HH products arrive later than expected										
134	Delayed income for forest products										
135	Conflict										
136	HIV/AIDS										
99	Others (specify)										

CODE A
Yes= 1 No=0
CODE B
Most severe =1
Second Most severe=2
Third most severe=3
CODE C
Yes= 1 No=0
CODE D
No other HH=0
Some other HH=1

COPING CODES
1-spent cash on savings
2-sent children to live with relatives
3-sale of various assets and products
a-sold assets
b- sold animals
c- sold more crops
d-sold farm land
e- Sold food that would otherwise be used for household consumption
4-Worked longer hours or more
5-Other members who were not working went to work
6-Started a new business
7-Got children from school to work
8-went elsewhere to find work
9-Borrowing
a-Borrowed money from relative
b-Borrowed money from money lender
c- borrowed money from institutions-bank
10- Received assistance
a-Received help from religious institution
b- Received help from international bodies
c- Received help from local NGOs
d-Received help from government
e-Received help from family and friends
11- Reduced food consumption
12-Consumed lower cost but less preferred food
13- Reduced non-food expenditures
14- Harvested premature crops
15- Changed cropping patterns or types of crops planted
16-Spiritual effort-prayer, sacrifices, consulted diviner
17-Rented out land
18-Dig terraces
19-Plant trees
20-Seek for compensation
21-Insurance
22-Traditional methods of dealing with pests
a.Push and pull: plant crops that are not affected by pest close to core crop
b-Use ashes to deal with pests
c-Use kerosene to deal with pests
25-Steal forest resources
26- Did nothing
99-others (Specify)

SECTION 5.2 HOUSING AND WATER SANITATION				**Response**
V1	What type of dwelling does the household live in?	1=Permanent 2=Semi permanent	3=Temporary	

V2	Does your household own this dwelling? Do you rent it or do you live here without pay	1= owns 2=pays rent	3= no rent with consent of owner 4=no rent(squatting)	
V3	What is the predominant wall material of the main dwelling unit?	1=natural walls (kane grass, mud) 2=rudimentary walls (plywood, cardboard, reused wood, iron sheets)	3=finished wall(cement, stone with lime, bricks, wood planks) 4=not sure	
V4	What is the predominant roof material of the main dwelling material	1=natural roofing (kane grass, mud) 2=rudimentary roofing (plywood, cardboard, reused wood, iron sheets)	3=corrugated ironsheets, tin cans 4=finished roofing (asbestos sheets, concrete, tiles) 5=not sure	
V5	What is the predominant floor material of the main dwelling?	1=natural floor(earth, sand, dung) 2=rudimentary floor (wood planks, palm/lbamboo)	3=finished floor(polished wood, ceramic tiles, cement)	
V6	What is the main type of appliance used for cooking?	1=traditional/improved stone fire 2=ordinary jiko 3=improved jiko	4=kerosene stove 5=Gas/electric cooker 6=other	
V7	What is the main source of energy for cooking?	1=firewood/grass 2=electricity 3= Gas 4=biogas	5=kerosene 6=charcoal 7=dung/crop residue 8=other (specify)	
V8	What is the main source of lighting in your household?	1=KPLC 2=own generator 3=community/neighbour 4=solar panels	5=battery 6=Kerosene 7=Candle 8=other	
V9	What is the main source of water used for food preparation in your household	1= public provider 2=private provider 3=borehole 4=piped into plot/yard 5=public tap 6=dug well	7=rain water collection 8=vendors(tankers, truck, bicycle) 9=surface water (river, stream, pond, dam, lake) 10=bottled water 11=other (specify)	
V10	Do you use any methods to make the water safe to drink or do you buy bottled water for drinking	1= nothing 2=boil 3=bleach/ chlorine 4=see through a cloth 5=water filter(ceramic, sand etc)	6=solar disinfection 7=let it stand and settle 8= buy bottled water 9= other	
V11	How much solid waste does your household dispose off each week (estimate in gorogoro or debe)	1= gorogoro (2kg) 2= Debe (20kg)	3= not sure	
V12	How much of this solid waste is food waste (Include all food that is left over but not used and all food that is stored and went bad. Do not include peelings)	1= gorogoro (2kg)	2= Debe (20kg)	
V13	Do you recycle/ reuse any of your food waste and how?	1=no-I throw all my left overs away 2=yes, I make compost 3= yes, I separate food wastes from all other solid waste 4=yes, I give my left overs to other people for free	5=yes, I give my leftovers to other people as part of their wage 6=yes I use my leftovers to feed pets and other animals 7=others (specify)	
V14	What kind of toilet facility does your household usually use?	1=flush toilet 2=ventilated improved pit latrine 3= pit latrine	4=bucket toilet 5=no facility/ bush/field 6=other	

5.3: HOUSEHOLD ASSETS

Which of the following assets are owned by your household? Please indicate the number and value of implements and other large household items that are owned by the household.

	Asset	**0=No 1=Yes**	**1. No. of units Owned**	**2. Total value (current sales value of all units, not purchasing price)**		Asset	0=no 1=Yes	No of units owned	**. Total value (current sales value of all units, not purchasing price)**		
1	Electricity					16	Dvd player				
2	Radio					17	Cassettte/Cd player				
3	Television					18	Car/truck				
4	Smart phone					19	Tractor				
5	Non- mobile telephone					20	Motorcycle				
6	Refrigerator										

7	Solar panel				21	Bicycle			
8	Table				22	Handphone /phone			
9	Chair				23.	Stove for cooking (gas or electric only)			
10	Sofa				24	Fishing boat and boat engine			
11	Bed				25	Chainsaw			
12	Cupboard				26	Plough			
13	Clock				27.	Scotch cart			
14	Computer				28	Wooden cart or wheelbarrow			
15	Microwave oven				29	Pump			

SECTION 6.1 WILLINGNESS TO PAY (WTP) OR WILLINGNESS TO CONTRIBUTE LABOUR (WTCL) FOR FOREST CONSERVATION

1	Based on the benefits and services you derive from the forest, and if forest services were to be availed at a fee or you were required /expected to contribute labour for forest conservation Would you be willing to pay fee or contribute labour for conservation of the forest?	0=not willing 1=WTP fees 2=WTCL

2 If the choice is 1or 2 how much fees will you be willing to pay or to contribute per month

S/N	WTP(Ksh per month)			Response		WTCL (Man-days month)				
Randomly assigned	Initial bid	Higher bid	Lower bid	Initial bid	Next bid	Initial bid	Higher bid	Lower bid	Initial bid	Next bid
1	75	150	37.5			2	4	1		
2	175	350	87.5			5	10	3		
3	250	500	125			7	14	4		
4	310	620	155			9	18	5		
5	420	840	210			12	24	6		
Code				1=yes 0=otherwise	1=yes 0=otherwise					

3	If you are not willing to pay or contribute labour for forest conservation, what is the main reason?	1=it is expensive 2= conservation is the government's role 3=I do not need forest service 4=other(specify)

SECTION 7.1 - FOOD INSECURITY EXPERIENCE SCALE **FS**

WE WOULD NOW LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR FOOD CONSUMPTION IN THE LAST 12 MONTHS. DURING THE LAST 12 MONTHS, WAS THERE A TIME WHEN…

Ask the respondent questions 1 – 8, then assess the level of food insecurity using the provided table.

		YES	NO	NS/DK
ITEM	**QUESTION: DURING THE LAST 12 MONTHS, WAS THERE A TIME WHEN…**			
FS1	You or others in your immediate household were worried you would run out of food because of the lack of money or other resources?	**[ ]**	**[ ]**	**[ ]**
FS2	You or others in your immediate household were unable to eat healthy and nutritious food because of the lack of money or other resources	**[ ]**	**[ ]**	**[ ]**
FS3	You or others in your immediate household ate only a few kinds of food because of a lack of money or other resources	**[ ]**	**[ ]**	**[ ]**
FS4	You or others in your immediate household had to skip a meal because there was not enough money or other resources to get food	**[ ]**	**[ ]**	**[ ]**
FS5	You or others in your immediate household ate less that you thought you should because of a lack of money or other resources	**[ ]**	**[ ]**	**[ ]**
FS6	Your immediate household ran out of food because of the lack of money or other resources	**[ ]**	**[ ]**	**[ ]**
FS7	You or others in your household were hungry but did not eat because there was not enough money or other resources for food?	**[ ]**	**[ ]**	**[ ]**

FS8	You or others in your household went without eating for a whole day because of a lack of money or other resources?		**[ ]**	**[ ]**	**[ ]**
PRELIMINARY ASSESSMENT (FOR THE INTERVIEWER TO COMPLETE) *Assign one point for each YES answer to the food insecurity experience scale. Then assess their food insecurity level using the table below.*					
		Security	**Slight insecurity**	**Moderate insecurity**	**Severe insecurity**
	Scores (add 1 point for each YES response)	0	1 to 3	4 to 6	7 to 8
FS9	Level of food security in the household	**[ ]**	**[ ]**	**[ ]**	**[ ]**

7.2 DIETARY DIVERSITY

Please describe the foods (meals and snacks) that you or any member of your household ate or drank yesterday during the day and night. Start with the first food or drink of the morning. Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned

Breakfast Snack	Snack	Lunch	Snack	Dinner	

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.		Did any of these groups consume foods in the listed food groups 1=yes 0=No			Frequency of the foods consumed for the past 7 days
		Household	Children 1-5 years	Women (15-35 years)	
Code	**Food group**				
FG1	Cereals and derived products, non-fortified: maize, rice, sorghum, millet, wheat, oats, pearl millet, ugali, porridge, chapati, mandazi, bread, pasta and breakfast cereals [PROBE: flour from own grains milled at small mills]				
FG2	White roots and tubers, plantains: Irish potato, white sweet potato, cassava, yams, arrowroot, green banana, plantain)				
FG3	Vitamin A rich vegetables and tubers: carrots, pumpkins, butter nuts, orange-fleshed sweet potato, red sweet bell pepper				
FG4	Dark green leafy vegetables: spinach, kales (Sukuma wiki), cow peas leaves (kunde), bean leaves, managu, amaranthus (terere), stinging nettle (thabai/oilo), sweet potato leaves (matembele), non- poisonous cassava leaves (kisamvu), spider weed (saget/dek/akeyo/ sagaa), pumpkin leaves (susa), arrow root leaves (matekyo)				
FG5	Other vegetables: green pepper, onions, cauliflower, cabbages, cucumbers, eggplant, courgettes, French beans, okra, leeks, broccoli, celery				
FG6	Vitamin A rich fruits and their natural juices: mango, papaya				
FG7	Other fruits and their natural juices: guava, avocado, pineapples, green plums, green grapes, gooseberries (nathi), oranges*, lemons, limes, tamarind, loquats, zambarao (jamna), ripe bananas, custard apples, peaches, thorn melon, melons, pomegranates (kungu manga), wild fruits				
FG8	Legumes and pulses: Bambara nuts (njugumawe/bande), beans, peas cow peas, pigeon peas (mbaazi), soya beans, dolicos beans (njahi), green grams, lentils				
FG9	Organ meats: Liver, kidney, heart, other organ meats or blood-based food				
FG10	Flesh meats: Edible insects, goat meat, game meat, pork, beef, mutton, rabbit, donkey, chicken, guinea fowl, turkey, geese, ducks, quail, wild birds, doves				
FG11	Eggs				
FG12	Fish and sea foods: include all fresh, frozen or dried fish				
FG13	Milk and milk products: Milk from goats, camels, cows and sheep, fermented milk, mursik, amarurano, yoghurt, cheese and other products				

FG14	Sugar, sweets and soft drinks: Table sugar, juggary, sugar cane, honey, sugar-based cold drinks (sodas, pops, fruit drinks with added sugar), other savored drinks and concentrates; sugary foods like candies, cakes, chocolate etc.					
FG15	Sauces, condiments, processed food and snacks: mustard, ketchup, mayonnaise, barbecue sauce etc. Ready meals, processed meats, salty snacks (chips etc.)					
FG16	Fats and oils : Oil, fats or butter added to food or used for cooking					
FG17	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday?					
DGA1	Would you say that the way you eat now is different from how you eat in the rest of the year?					
1=very different	2=somehow different	3=not different	4= not sure /Don't know			

SECTION 8.1: INSTITUTIONAL AND SUPPORT SERVICES		**RESPONSE**
1) Are you or any member in your household a member of a registered farmers' group or association?	1=Yes 0=No	
2) If yes, to 1 what type of group?	1= Self-help group 2= SACCO 3= CBO 4= A producer cooperative society5= other (specify)	
3) Did any of the household members try to obtain or access credit over the last one year	1= Yes 0=No	
4) Did you obtain or get the loan/credit	1= Yes 0=No	
5) If yes to 4 who was the provider?	1= Commercial bank 2= Micro-finance institution 3=cooperative 4= shylock/ local money lender 5=mobile credit (Mshwari,branch,tala) 6=Sacco 7=Family/friends 8=Chama group 9= contractual out grower arrangement 10=Other(please specify)	
6) What was the loan used for	1Agricultural investment, 2-Agricultural expenses (fertilizer, seeds, pesticides,) 3-business related expenses, 4-capital for business, 5-payback other debt, 6-buy durable household goods, 7-buying food, 8-buying other consumption goods egcellphone, credit, clothes 9-medical treatment, 10-ceremony (wedding, funeral), 11-study, 12-relend to family members or relatives, 14-house/land purchase/construction, 13-Other(specify)	
7) Name of nearest town/market	Indicate name	
8) What is the distance from the homestead to nearest market	Km	
9) What is the distance from the homestead to the nearest tarmac road?	Km	
10) Did you receive any extension services in the last 12 months	1=Yes 0=No	
11) If yes to 10, what type of extension was it?	1=Crop 2=Livestock 3=Crop and livestock 4= conservation practises	
12) Who (main) provided the extension services	1=Government 2=private extension 3= cooperative/farmer association 4=NGO'S 5=Others(please specify)	
13) Who in the household accessed the service	1= HH 2= spouse 3=child 4= farm manger 5=other (specify)	
14) What was your level of satisfaction with the extension service	1= very dissatisfied 2=dissatisfied 3=neutral 4=satisfied 5=very satisfied	
15)Do you have an insurance cover?	1=Yes 0=No	
16)If yes in please specify	1-life insurance, 2-property insurance, 3-health insurance, 4-Disability insurance,5-livestock insurance, 6-crop insurance,7-funeral insurance, 8-accident insurance, 9-others (specify)	