

**The Potential of Agro-Ecosystems Payments for Ecosystem
Services to Provide Ecosystem Services and Poverty
Reduction in Developing Countries: A Case Study of the
EPWS Program in Tanzania**

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The candidate confirms that the work submitted is his own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to his work has been explicitly indicated below. The candidate confirms that appropriate credit has been given where reference has been made to the work of others.

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All the above manuscripts constitute an important part of my thesis. I am lead author on these articles as they represent the publications generated from PhD studies. Consequently, I use my own collected data, empirical results and analysis. The articles are co-authored with my supervisors whose role was in the recommendation of revisions and edits to these articles.

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Abstract

This thesis investigates the effectiveness of agro-ecosystem based PES programs to provide ecosystem services and achieve poverty reduction. A case study from Tanzania known as the “equitable payments for watershed services (EPWS) program” piloted between 2008 and 2012 in Morogoro region has been used as the basis for an in-depth empirical study of an agro-ecosystem based PES program. The case-study approach has combined mixed methods quasi experimental research design and propensity score matching technique to prioritise attribution of the livelihood and environmental outcomes of the intervention, which remain under-utilized in evaluation of conservation interventions.

The thesis findings provide insights that while the poor can participate in agro-ecosystem PES programs, their participation can be hindered by initial investment costs of inputs such as on manure, improved seeds, hoes and spades. Farm size, farmers’ access to information, participation in the design phase, and the change in farm management required by the program are significant determinants of program participation. Also, while PES payments contribute to local livelihoods, the indirect financial and non-financial benefits provide greatest contributions to livelihoods. In relation to additionality impact, program participation increases the number of sustainable land management practices and land under agro-forestry and reforestation amongst program participants. Furthermore, expected benefits such as crop yields from constructed terraces and manure, fire wood and timber products

from agro-forestry and afforestation interventions are likely to increase the life span of the practices.

The design of agro-ecosystem PES programs should include upfront payments in addition to other incentives which should be made timely in phases to ensure compliance. Local training and paraprofessional, external training and both enhancement of local formal and informal rules are essential to enhance the adoption of practices and to stop illegal activities such as forest reserve encroachment, illegal logging and fire.

Keywords: quasi-experiment; propensity score matching; ecosystem services, payments for ecosystem services (PES); forest, agricultural based PES program, participation, livelihoods; agriculture; sustainable land management; water; Tanzania, Africa

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Chapter 1: Introduction

1.1 Background

Agro-ecosystems are among the Earth's major ecosystems that supply many ecosystem services beyond merely providing food, fiber, and fuel (Swinton et al., 2006). However, degradation of agro-ecosystems has been increasing at alarming rate because many ecosystem services produced by these landscapes exhibit the characteristics of public good, resulting into externalities (Ferraro and Kiss, 2002; MA, 2005a; Wunder, 2005; Paavola, 2007; Engel et al., 2008; Paavola, 2009). According to Pigou (2013), externalities are environmental problems for which no price is paid and no payment is received. Due to this, efficient allocation of resources cannot be achieved when externalities prevail (Paavola, 2007). To maximize social welfare, Pigou (2013) suggested that generators of positive externalities should be subsidized while the generators of negative externalities should be taxed.

Payments for ecosystem services (PES), are designed in such a way that those who provide ecosystem services are rewarded through transfer of payments from those who benefit from ecosystem services (Pagiola and Platais, 2005; Wunder, 2005; Engel et al., 2008). This PES mechanism has been defined by Wunder, (2005; 3) as “... a voluntary transaction where well-defined ecosystem services (or land uses likely to secure those services i.e. water quality and quantity) are bought by a minimum of one service buyer, from a minimum of one service provider, if and only if the service provider continuously secures service provision (conditionality)”.

Globally, there are numerous PES initiatives being implemented at varying scales, ranging from local initiatives for conserving watersheds to regional and global arrangements for biodiversity and carbon sequestration services (Landell-Mills and Porras, 2002; Corbera et al., 2007; Wunder et al., 2008). Other initiatives are for landscape beauty and for bundles of several ecosystem services (Landell-Mills and Porras, 2002). In their study, Landell-Mills and Porras (2002) identified about 300 programs and many other programs have been established since then (Wunder et al., 2008; Schomers and Matzdorf, 2013).

Two broad categories of PES programs have been identified by Zilberman et al.(2008). The first category is land diversion or forest based PES programs, where lands are diverted from agricultural production to other uses and the second is the working-land or agro-ecosystem based PES programs, where land remains in agriculture but production activities are modified to achieve environmental objectives. The analysis of these categories suggests that the majority of PES programs in developing countries are implemented for services nested in forest ecosystems (Landell-Mills and Porras, 2002) rather than for services nested in agro-ecosystems (FAO, 2007b; Wunder et al., 2008; Ribaud et al., 2010). In contrast, most PES programs in more developed countries such as in the European Union and United States are implemented for services nested in agro-ecosystems (Baylis et al., 2008; Wunder et al., 2008; Schomers and Matzdorf, 2013).

In recent years, PES programs have been developed in developing countries with twin objectives, which are to supply ecosystem services and poverty reduction

(FAO, 2007b; Pagiola et al., 2008; Branca et al., 2011; Schomers and Matzdorf, 2013). In developing countries, PES programs are expected to be more cost effective than other conservation approaches such as integrated conservation and development programs; and sustainable by creating a win–win scenario from mutual self-interest of service providers and users where conservation can generate ecosystem services and improve livelihoods (Pagiola and Platais, 2007; Engel et al., 2008; Miles and Kapos, 2008). Also, PES can generate new financing, which would not otherwise be accessible for conservation, while it can also be efficient by conserving services whose benefits exceed the cost of providing them (Engel et al., 2008; Miles and Kapos, 2008).

However, challenges of attaining more than one objective with any single policy tool is emphasized in Tinbergen's (1956) classic research on policy design. His analysis suggests that the effort to achieve both conservation and poverty reduction objectives with PES may be unrealistic (Zilberman et al., 2008) given that the link between environmental conservation and poverty alleviation is not necessarily linear (Wunder, 2005). Conversely, Huang et al.(2009) suggest that the dual PES objectives can only be achieved if (1) the poor control the lands that provide significant ecosystem services; (2), the poor are able to provide ecosystem services at a lower cost than the less poor; (3), the poor can be contracted at low transaction costs; and (4), the land use changes required to provide ecosystem services do not reduce the demand for labour or induce other indirect effects that could increase poverty.

A number of challenges can limit the feasibility of PES to achieve the supply of ecosystem services and poverty reduction objectives. These include weak institutions and missing markets (Muller and Albers, 2004), missing technical support, availability of credits, insecure land tenure and a lack of availability and access to information (Rios and Pagiola, 2009). Also, PES programs may result in discrimination towards poor small land holders who may lack formal land tenure titles or access to credit (Grieg-Gran et al., 2005; Kosoy et al., 2007). In addition, PES can delink communities from development when the poor are exposed to unevenly powerful institutions that deprive them of their legitimate land development aspirations (Romero and Andrade, 2004; Wunder, 2007). PES can also erode culturally rooted not-for-profit conservation values (Wunder, 2007).

These challenges suggest that, with huge investments being made in the conservation of ecosystem services in developing countries, greater knowledge of their effectiveness on rural development and conservation outcomes is needed (Ferraro and Pattanayak, 2006; Pattanayak et al., 2010). However, when it comes to evaluating conservation intervention, Ferraro and Pattanayak (2006:1) argues that *“the field of ecosystem protection and biodiversity conservation lags behind most other policy fields (e.g., poverty reduction, criminal rehabilitation, disease control)”*. They also argue that *“...far too long, conservation scientists and practitioners have depended on intuition and anecdote to guide the design of conservation investments”* (Ferraro and Pattanayak, 2006:1).

Impact evaluation is an essential mechanism to demonstrate accountability in spending funds on programs intended to deliver outcomes (White, 2006). It can enhance learning about change process, what worked, what did not and why (Leeuw and Vaessen, 2009). It can also justify how well a development project achieved its desired objectives and thus met payers expectations or how results compare with alternative uses of the invested resources (Bamberger et al., 2010). Knowledge gained from impact evaluation studies can thus provide critical input for the appropriate design of future programs.

While there are impact studies for larger national level PES programs such as Uchida *et al.*, (2007), Robalino *et al.*, (2008a) and Arriagada *et al.*, (2009), rigorous empirical studies on the livelihood and environmental outcomes of small scale agro-ecosystem based PES programs in developing countries, and Africa in particular, remain sketchy (Ferraro, 2009b). In developing countries and Africa, the implementation of PES programs on agro-ecosystems is recent but an interest in achieving a supply of ecosystem services and in rural development is considerable (Ferraro, 2009b; Branca et al., 2011; Lopa et al., 2012).

Therefore, this thesis aims to investigate the effectiveness of agro-ecosystem based PES programs to provide ecosystem services and achieve poverty reduction to contribute to a geographical knowledge gap in the context of resource poor agro-ecosystems in developing countries and sub-Saharan Africa in particular. This research uses a case study from Tanzania known as the “equitable payments for watershed services (EPWS) program” piloted between 2008 and 2012 in Morogoro region as the basis for an in-depth empirical study of

an agro-ecosystem based PES program. This case study promotes sustainable land management (SLM) practices such as terracing, agro-forestry and reforestation in the Kibungo sub-catchment in the Uluguru mountain watersheds to enhance water quality and quantity to downstream beneficiaries and reduce poverty to the service providers upstream (Lopa et al., 2012).

In addition, by using quasi experimental mixed methods research design with propensity score matching, this study contributes to currently limited research that rigorously evaluates the outcomes and impacts of conservation interventions. Many conservation interventions including integrated conservation and development programs (ICDPs), subsidies and PES lack explicit frameworks for evaluating their success due to the non-random nature of their design (Ferraro and Pattanayak, 2006; Ferraro, 2009a; Greenstone and Gayer, 2009; Ferraro and Pressey, 2015). As such, it is often difficult to disentangle the effects of an intervention (i.e. conservation outcomes or impacts such as the change in land use) from the effects of other policy measures and broader economic trends (Ferraro and Simpson., 2002; Ferraro and Pattanayak, 2006; Wunder, 2007; Margoluis et al., 2009; Djamhuri, 2012).

1.2 The Specific Objectives of the Thesis

- i. To examine the factors that affect farmer participation in the EPWS program.
- ii. To evaluate the direct and indirect financial and non-financial livelihood outcomes of the EPWS program and distribution of outcomes.

- iii. To evaluate the environmental effectiveness of the EPWS program in terms of its additionality, leakage effects, permanence of SLM practices and cost effectiveness in the supply of water ecosystem services.

1.3 Thesis Structure

Beyond this chapter which has introduced the thesis, Chapter 2 examines the pertinent literature related to the aim and objectives of this research. It examines the management of agro-ecosystems in developing countries, the basic principle of PES and the implementation of PES. The chapter also reviews the development and implementation of payments for watershed services (PWS) in Africa, and provides a critical review of the sustainable livelihoods framework that has been widely used in the impact assessment of conservation and development programs. The chapter concludes with a synthesis and reflection, highlighting the main research gaps that the thesis addresses.

Chapter 3 then outlines the research approach, describing the case study, study location and research methodology. The multi-method quasi-experimental research design which incorporates quantitative and qualitative methods is also explained including the implementation of propensity score matching. The chapter further explains data collection methods, field work and approaches to the analysis of quantitative and qualitative data as well as description of the study villages.

In order to fulfil the first thesis objective, Chapter 4 examines participation in the EPWS program and uses both quantitative and qualitative methods to examine the determinants of landholders' decisions to participate. The findings indicate that poor households are able to participate in the EPWS program and that their participation is not limited to simpler practices such as grass strips and trash lines but they also implement practices such as construction of terraces and agro forestry. On the determinants of participation, the findings show that farm size, farmers' access to information, participation in the design phase of the program, and the change in farm management required by the program significantly determine farmer participation in the EPWS program.

Chapter 5 fulfils objective two of the thesis investigating the direct and indirect financial and non financial livelihood impacts of the EPWS program. The chapter uses a mixed methods quasi-experimental research design employing both quantitative and qualitative methods with propensity score matching. The findings show that the EPWS conditional payments are an important source of cash income to farmers that have adopted SLM practices. In addition, the program has generated significant co-benefits such as increased land value, sources of income, average annual income, and crop harvests and livestock. Non-financial impacts such as the amount of training and relationships of trust amongst program participants were also increased. Also, the findings show that the increase in land value has reduced access to land amongst landless households who used to rent idle land.

Chapter 6 fulfils objective three of the thesis examining the environmental effectiveness of the EPWS program. The chapter investigates the EPWS program's additionality effect, conditionality, permanence, leakages and spillovers, and its cost effectiveness in terms of transaction and opportunity costs. In relation to additionality, the findings show that the land under agro-forestry and reforestation practices has on average increased by 6.92% amongst the program participants. Also, the program participants have a greater number of SLM practices than non-participants. In addition, the temporal increase in program enrolment indicates the willingness of farmers to provide ecosystem services through PES. The program has also resulted in decreased incidences of fire, forest encroachment and illegal logging.

Chapter 7 provides a general discussion of the research findings by integrating the results from Chapters 4, 5 and 6. It provides the summary of findings, methodological reflections and synthesis of findings.

Chapter 8 is the concluding chapter of the thesis. It explains the implications of the findings and recommends future research direction.

Chapter 2: Literature Review

2.1 Chapter Outline

This chapter provides a general review of the literature on ecosystem services, payments for ecosystem services (PES) including its definition, criticisms and implementation around the world as well as livelihood and environmental aspects of PES and evaluation in order to outline state of art, gaps and identify possible areas of contribution for this research. More focused reviews of literature related to each objective are later presented in each empirical chapter (Chapters 4, 5 and 6). This chapter begins by examining literature on the concept of ecosystem services and agro-ecosystem services and the challenges of managing ecosystem services in agro-ecosystems in developing countries. It then examines the basic principle of PES and its understanding in different contexts. In addition, the chapter examines the implementation of PES in developing and developed countries and the implications of actual service user financed and government financed PES programs. Furthermore, the chapter explores the implications of the forest based (i.e. land diverting) and agro-ecosystems (i.e. land modifying) based PES programs on the supply of ecosystem services and poverty reduction. In addition, the chapter provides a review of the development and implementation of the payments for watershed services initiatives and constraints to its development in Africa. Additionally, the chapter reviews evaluation methods that can be useful in the evaluation of conservation intervention like PES. The chapter concludes with a synthesis and reflection, highlighting the main research gaps that the thesis addresses.

2.2 Ecosystem Services Concept

According to the Millennium Ecosystem Assessment (MA), ecosystem services are “*the benefits people obtain from ecosystems*” (MA, 2005a: v). These benefits are classified as supporting services, regulating services, provisioning services and cultural services (see Table 2.1) (MA, 2005a). Agricultural ecosystems (agro-ecosystems) are among the Earth's major sources of ecosystem services that are directly managed by humans for food, fiber, and fuel production (Swinton et al., 2007). As human managed ecosystems, agro-ecosystems supply ecosystem services and demand other ecosystem services (Swinton et al., 2007). They supply provisioning, regulating and cultural services while at the same time demand supporting services such as water and fertile soils to make them productive (MA, 2005a; FAO, 2007a). Among the most diverse classes of services provided by agro-ecosystems are regulating services which include the population dynamics of pollinators, pests, pathogens and wildlife, as well as fluctuations in levels of soil loss, water quality and supply, and greenhouse gas emissions and carbon sequestration (Swinton et al., 2007).

Table 2.1. Classification of ecosystem services according to MA 2005

Types of Ecosystem Service	Example of Ecosystem Services
1.Provisioning services	These include food, fiber, fuel, genetic resources, biochemical, natural medicines, and pharmaceuticals, ornamental resources and fresh water.
2.Regulating services	These include air quality regulation, climate regulation, water regulation, erosion regulation, water purification and waste treatment, disease regulation, pest regulation, pollination and natural hazard regulation.
3.Cultural services	These include cultural diversity, spiritual and religious values, knowledge systems (traditional and formal), educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values and recreation and ecotourism.
4.Supporting services	These include soil formation, photosynthesis, primary production, nutrient cycling and water cycling.

Source: The Millennium Ecosystem Assessment (2005a)

Despite their benefits to human well-being, many of the World's ecosystems, including agro-ecosystems are being degraded at an alarming rate (MA, 2005a; FAO, 2007b). From an economic perspective, degradation of ecosystems occurs because many ecosystem services are externalities from the point of view of those who own and manage the systems (i.e. forest land or agricultural land) that provide services (Engel et al., 2008). Being externalities, Jenkins et al. (2010: 1060) argue that *"ecosystem services have been traditionally underprovided due to their lack of value in the marketplace"*. As such, society fails to establish institutions that internalize the value of services provided by intact ecosystems (Pattanayak et al., 2010).

This challenge has been enhanced by the fact that many ecosystems in developing countries including sub-Saharan African are non-excludable as it is often difficult to exclude others through physical or institutional barriers from exploiting the resources (Ostrom et al., 1994; Ostrom and Hess, 2007; Quinn et al., 2007; Fisher et al., 2009). Natural or man-made resources that exhibit this character are known as common pool resources (CPRs). According to Hardin, (2009) common pool resources are degraded because of overuse because the open access nature of the commons allows the users to act in ways that maximize their individual benefits at the expense of costs that are often shared between all users.

While exploitation of ecosystems benefited human well-being through increased outputs of food, timber, fresh water, fibre and fuel, (MA, 2005a), the full costs associated with these gains have become apparent in some societies (MA,

2005a; FAO, 2007b). Intensive agriculture and water withdrawal from rivers have in many parts of the world caused the decline of fresh water supply and quality from the flow of nutrients, sediments and dissolved salts (MA, 2005a; FAO, 2007b). Other costs include disruption to climate regulation, air quality regulation, erosion regulation, pest regulation and pollination services (MA, 2005a).

Valuation studies of the social costs and benefits of conserving ecosystem services show that the benefits of conservation outweigh the cost of conservation management (Balmford, 2002; Turner, and Daily. 2008). They also report tremendous on-site and off-site direct and indirect benefits of ecosystem services conservation in increasing livelihood security (Costanza et al., 1997; de Groot et al., 2002; Zhao et al., 2004). Consequently, efforts to enhance conservation of ecosystems including to change the management of agricultural landscapes to reduce agro-ecosystem disservices or externalities are thought to be considerable (MA, 2005a; FAO, 2007b; Liniger et al., 2011). As such, various conservation measures including the adoption of SLM practices have received considerable interest for the management of ecosystems and agro-ecosystems in particular (Liniger et al., 2011).

The adoption of SLM practices has the potential to enable land users to maximise the economic and social benefits from the land while maintaining or enhancing the ecological support functions of land resources (Liniger et al., 2011: 19). SLM practices seek to manage soil, water, vegetation and animal resources in an interconnected manner by integrating ecological, economic and socio-cultural dimensions (Brown et al., 2007; Liniger et al., 2011). As such, they can

ecologically combat land degradation, socially improve food security and reduce poverty, and economically safeguard agricultural practices by paying back investments made on the management of land (Liniger et al., 2011). Table 2.2 shows examples of SLM practices identified by FAO (2003) that can sustain or increase land productivity, provide adequate water quantity, maintain water quality and reduce flooding and flood damage. These are grouped according to the expected objectives to be achieved.

Table 2.2. Sustainable Land Management Practices at a Watershed Level

Objectives	SLM practices
Sustain or increase land productivity	<ul style="list-style-type: none"> Adopt integrated nutrient management (i.e., making a judicious use of inorganic and organic fertilizers and amendments and strengthening nutrient recycling mechanisms) Adopt agro forestry practices (i.e., incorporating trees into agricultural systems and stressing the multifunctional value of trees within those systems) Introduce crop rotations (i.e., growing a series of different types of crops in the same area in sequential seasons) Eliminate the use of fires for land clearing and pasture reclamation, promote improvements in forage quality and quantity, improve grazing activities Reduce erosion and stabilize slopes through residue recycling Use water harvesting practices and efficient irrigation, maintain drainage to prevent water logging and salinity build up
Provide adequate water quantity and maintain water quality	<ul style="list-style-type: none"> Use soil cover to enhance water infiltration and prevent soil crusting Use crop, forage, and tree species with high water-use efficiencies Protect vegetative filter areas in riparian zones and wetlands to remove excess sediment and nutrients (nitrogen, phosphorus) Manage household and livestock waste to prevent pollution of surface and ground water Use contour plantings, vegetative strips, and terraces Use cover crops (i.e., crops planted primarily to manage soil fertility, soil quality, water, weeds, and pests) and perennial vegetation Adopt no-till farming (i.e., growing crops without disturbing the soil through tillage) Promote integrated pest management (using pesticides only when other options are ineffective)
Reduce flooding and flood damage	<ul style="list-style-type: none"> Protect and maintain wetlands and regulate floodplains Plant deep-rooted vegetation to enhance infiltration and water consumption by plants

Source: Adapted from FAO (2003)

Despite their ecological, social and economic benefits, the uptake of SLM practices by farmers in developing countries are often minimal (Liniger et al., 2011). Challenges that impede their uptake include knowledge gaps, opportunity costs related to land and adoption input costs such as labour and fertilizers or manure (Liniger et al., 2011). With regard to knowledge gaps, the adoption of new agricultural technologies is often hindered by lack of access to and inadequate training for farmers and local extension officers (TerrAfrica, 2007).

With regard to the opportunity costs, the poor landholders are often affected by short term or temporary negative economic returns associated with the transition phase from conventional agricultural to more sustainable practices with long run economic returns (FAO, 2007a; Liniger et al., 2011). For example, during the transition to new practices such as terraces, yields tend to vary or even decrease significantly as production systems adjust to a new equilibrium (Graff-Zivin and Lipper, 2008; Giller et al., 2009). These costs can lead to negative adoption behaviour on the part of poor landholders who may be confronted with higher risk aversion, higher discount rates and less capacity to make investments (Graff-Zivin and Lipper, 2008). In addition, household size, education levels and farming experiences are often reported to constrain SLM adoption in developing countries (Graff-Zivin and Lipper, 2008).

Other challenges that constrain the adoption of SLM practices in developing countries are access to and availability of financial facilities and uncertainties of land tenure. Often, poor landowners encounter difficulties in accessing financial facilities to support the up-front investment costs of adopting SLM practices

(FAO, 2007b; TerrAfrica, 2007). Also, insecure land tenure decreases the ability of a landholder to capture the future benefits of making investments in land productivity (Antle and Diagana, 2003). These challenges would suggest that, without adequate support to finance establishment, maintenance costs and opportunity costs, the adoption of SLM practices may not be possible for poor landholders (Amsalu and De Graaff, 2007). In addition, it has been argued that the failure to compensate landholders for the services their land provides to society is a key contributory factor in the rapid changes in land-use and decline of ecosystem services (Pagiola and Platais, 2005). As such, PES programs in agricultural lands are being implemented with the hope to reward conservation, bridging the barriers to adopting SLM practices by providing financial support and technical assistance (Branca et al., 2011) and thus potentially alleviating poverty in developing countries (FAO, 2007b; FAO, 2007a; Wunder et al., 2008; Branca et al., 2011). The adoption of SLM practices through PES payments are expected to improve the agricultural livelihoods of the landholders who adopt them as well as to improve ecosystem services such as water quality and quantity (Branca et al., 2011). In addition, PES programs are expected to improve social capital (Grieg-Gran et al., 2005) and increase land tenure security (Asquith et al., 2008; Engel and Palmer, 2008).

2.3 Payments for Ecosystem Services

2.3.1 The Basic Principle of PES

The basic principle of PES is that those who provide environmental services should be rewarded for doing so (Pagiola et al., 2005; Pagiola and Platais, 2005; Wunder, 2005; Engel et al., 2008; Kemkes et al., 2010; Muradian et al., 2010).

This means that mechanisms are put in place that transfer rewards or payments from those who benefit from the ecosystem service to those who manage it. This logic can be illustrated in three scenarios which include business as usual (scenario A, Figure 2.1), conservation without payments (scenario B, Figure 2.1), and conservation with PES payments (scenario C, Figure 2.1) (Pagiola et al., 2005; Wunder, 2005; Engel et al., 2008; Kemkes et al., 2010; Muradian et al., 2010).

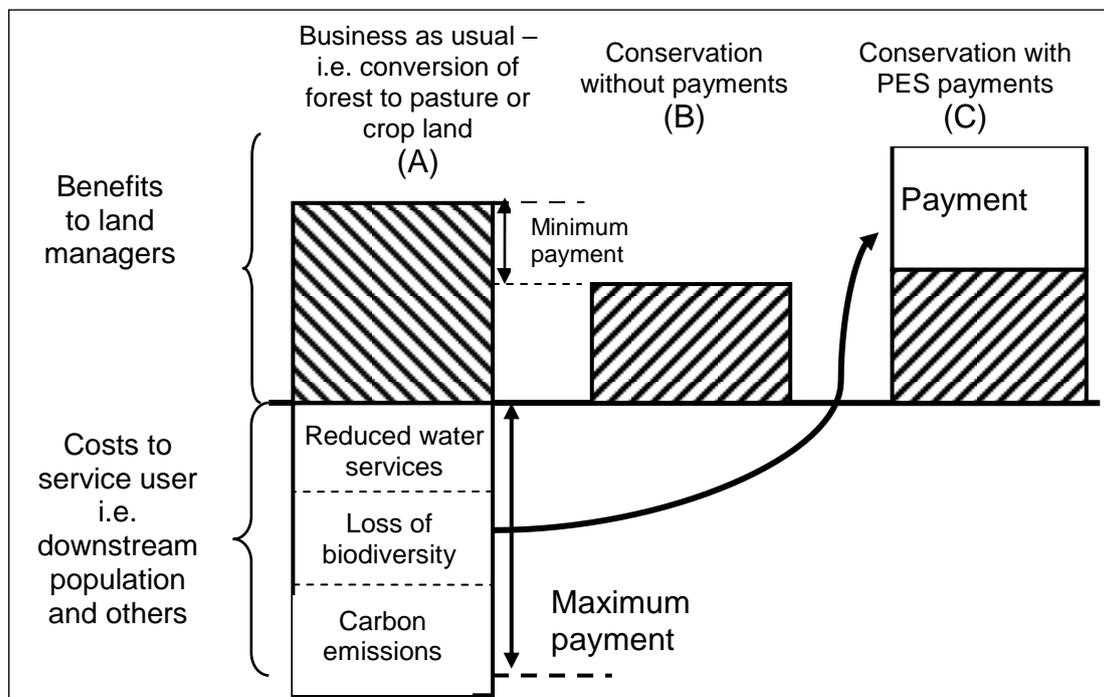


Figure 2.1. The logic of payments for ecosystem services

Source: Adapted from Pagiola and Platais (2005)

Figure 2.1 shows the basic logic of PES mechanisms. In the first scenario, land managers can receive more benefits from the conversion of forest lands into cropland or pasture than they could receive from forest conservation. When these alternative land uses are not sustainable, they can impose costs on the local and regional populations as well as on the global community (Engel et al., 2008).

These costs include the loss of benefit of services such as water filtration and improved water quality, groundwater recharge and preservation of scenic landscapes. Other costs could be carbon sequestration due to soil erosion from overgrazed hillsides and runoff of harmful nitrates from cropland to downstream catchments as well as the loss of biodiversity and carbon emissions on the global community (Millennium Ecosystem Assessment, 2005; FAO, 2007a; Engel et al., 2008).

Since the impacts of improved supply of ecosystem services are not often reflected in the incomes of land managers, provision of these services is therefore not a key consideration in most of their choices (Coase, 1960). Payments by those who benefit from services can make conservation the more attractive option for ecosystem managers, thus internalizing what would otherwise be an externality (Pagiola and Platais, 2005). In addition, for payments offered to induce land managers behaviour change (Engel et al., 2008), they must exceed the additional benefit the land managers would receive from alternative land uses and must be less than the value of the benefit to ecosystem service users for them to be willing and able to pay (Pagiola and Platais, 2005; Asquith et al., 2008). As such, the minimum payment has to equal the opportunity cost of a land manager (i.e. their benefits given up). For this to be successful, it has been shown that schemes that exploit ecosystem managers knowledge about their opportunity costs of ecosystem service provision are more efficient than top-down regulatory schemes (Kosoy and Corbera, 2010).

Paying the ecosystem managers the amount that covers their opportunity costs to adopt practices that ensure provision of ecosystem services is critical because, in the course of providing services they forego significant benefits from reducing the intensity or extent of their agricultural practices at plot or farm level (Kosoy and Corbera, 2010). Thus, payments are needed for compensation because when service users receive services without compensating providers for their provision, they would be “free-riding” at the provider’s expense (Engel et al., 2008). In this context, farmers would receive fewer benefits from adopting practices that generate ecosystem services without payments (Figure 2.1, scenario B) than business as usual. PES payments that do not cover land managers' opportunity cost may lead to low adoption of conservation practices required for the provision of ecosystem services (Ferraro, 2002; Wunder, 2007; Engel et al., 2008).

In addition to paying farmers for their opportunity costs, other costs that need to be covered are their transaction costs of establishing and maintaining improved land use practices (e.g., construction of terraces, preparation of tree nurseries, planting and maintenance of trees) (Wunder et al., 2008). Paying to cover farmers' opportunity costs and transaction costs are issues that have been discussed for other conservation approaches such as command and control regulations (Baland and Platteau, 1996; Bulte and Engel, 2006), community-based natural resource management (CBNRM) (Nelson and Agrawal, 2008) and integrated conservation and development projects (ICDPs) (Barrett and Arcese, 1995). For instance, research has shown that command-and control approaches in developing-countries are often hampered by high transaction costs, weak

governance, poor monitoring and enforcement at the local level (Baland and Platteau, 1996). Also, these practices create economic hardship and social conflicts related to distributional issues from the poor who depend on the resources (Bulte and Engel, 2006).

In this context, proponents of PES consider that the change of incentives for land use will maintain or restore the desired ecosystem service (Pagiola and Platais, 2007). This conceptualization assumes that decisions on land use and land use change are largely based on the net economic benefits that accrue to the landholder (Pagiola and Platais, 2005). Consequently, payments by service users can make conservation the most attractive option for service providers to adopt conservation practices (scenario C, Figure 2.1) (Wunder, 2005; Pagiola and Platais, 2007; Engel et al., 2008). In this way, PES can help to bridge the private interests of service providers and the public benefits of conservation management by funding actions that increase the levels of ecosystem services desired by society (Engel et al., 2008; Jack et al., 2008).

Increasingly therefore, PES is promoted as an alternative conservation approach to 'command and control' and other indirect approaches to natural resources management such as ICDPs, CBNRM and sustainable forest management (Pearce and Barbier, 2000; MA, 2005a; Wunder, 2005). Compared to indirect conservation approaches like ICDPs that require investments in alternative lines of production, the theoretical literature on PES shows that the direct nature of the PES mechanism to conservation and incentives makes it both more effective and more cost-efficient (Ferraro and Kiss, 2002; Ferraro and Simpson., 2002; Ferraro

and Pattanayak, 2006). PES targets conservation more directly through use of economic incentives (Figure 2.2), and as such, PES is viewed as (i) a potential means to generate new financing for conservation; (ii) a sustainable approach serving mutual self-interest of service users and providers; (iii) an efficient way to conserve services whose benefits exceed the cost of providing them, (Ferraro and Kiss, 2002; Nkonya et al., 2005; Wunder, 2005; Pagiola and Platais, 2007) and (iv) a means to improve rural livelihoods. On the improvement of livelihoods, it is argued that where providers of ecosystem services are poor landholders or disadvantaged communities, such payments can contribute to poverty alleviation (Ferraro and Kiss, 2002; Pagiola et al., 2005; Pagiola and Platais, 2007).

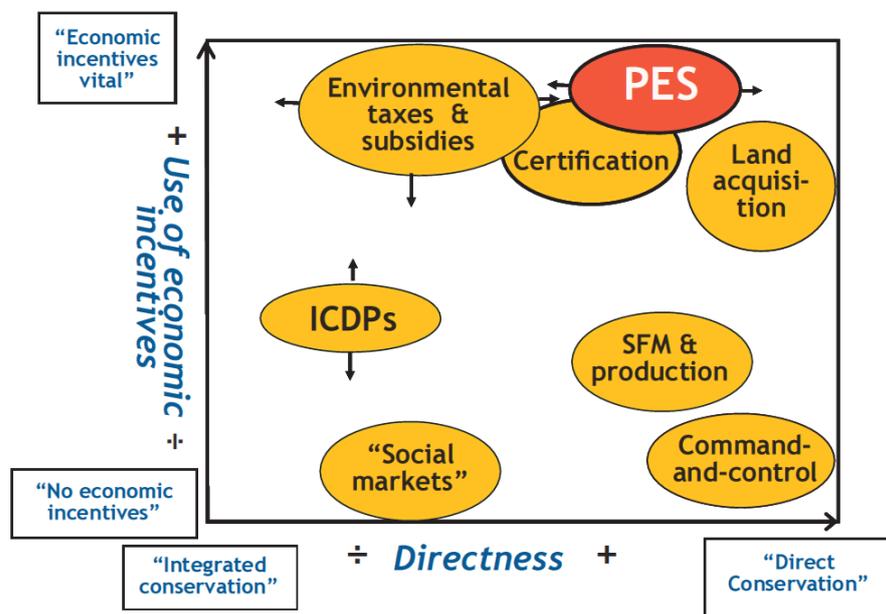


Figure 2.2. Comparison of PES to other conservation approaches on the basis of the degree to which PES relies on economic incentives and the extent to which the conservation of ecosystem services is targeted directly rather than integrated into other development approaches

Source: Wunder (2005: 6)

2.3.2 Critique of PES

Alongside the growing implementation of PES, voices critical of this way of managing ecosystem services are increasingly heard (Spash, 2011). They arise from debates against the use of market-based instruments for conservation whereby the optimists see the instruments as a promising policy option (Kinzig et al., 2011), while sceptics see it as a good example of neoliberalization of nature (McAfee and Shapiro, 2010). Some critics are concerned with the promotion of environmental valuation and market solutions (i.e. economic reasoning that rationalizes PES schemes) as core strategies to solve environmental problems (Engel et al., 2008; Spash, 2011). This way of thinking is seen as a strategy of undermining or rejecting the utilitarian rationale for conservation that promotes nature preservation for the intrinsic value of different entities in nature regardless of use and non use values (McCauley, 2006).

According to Kosoy and Corbera (2010), PES mechanism is commodity fetishism as it reduces ecosystem values to a single exchange-value measure that obscures the collective relations embodied in producing ecosystem services. The same view is shared by Krall and Gowdy (2012) who criticize the practice of reducing all the functions of nature to exchange value. This line of critique is based on the Polanyi's (1944, p.73) work who argued that to *“allow the market mechanism to be sole director of the fate of human beings and their natural environment, indeed, even of the amount and use of purchasing power, would result in the demolition of society.”* In all these arguments, fear has been raised that commercial conservation may erode culturally rooted not-for-profit conservation values (Vogel, 2002; Romero and Andrade, 2004; Wunder, 2006).

It has also been argued that market-like conservation tools may prioritize efficiency over fairness where the poor landholders sell cheap as they may not always be able to negotiate and participate in the PES programs fairly due to lack of information, informal land entitlement or unfavourable procedural rule (Landell-Mills and Porras, 2002; Pascual et al., 2010). As such, PES skeptics fear that the mechanism might bring back the fences by decoupling conservation from development and that asymmetric power distribution will enable powerful conservation consortia to deprive communities of their legitimate land-development aspirations (Vogel, 2002; Romero and Andrade, 2004; Wunder, 2006). This is because setting up the price for an ecosystem service is often a top-down, expert-led exercise, in which ecosystem service providers may not intervene (Kosoy and Corbera, 2010).

2.3.3 PES in Context

PES remains a multi-faceted term with many diverse definitions coexisting. However, a seminal definition by Wunder (2005: 3) views PES as *“(1) a voluntary transaction where (2) a well-defined ecosystem service (ES) or (a land-use likely to secure that service) (3) is being ‘bought’ by a (minimum one) ES buyer (4) from a (minimum one) ES provider (5) if and only if the ES provider secures ES provision (conditionality)”*. While this is a seminal and widely used definition of PES, very few PES programs in reality achieve these standards (Porras et al., 2008; Sommerville et al., 2009; Swallow et al., 2009; Muradian et al., 2010). The definition has been criticised because the voluntary transaction criterion fails to recognise non-voluntary approaches such as taxes or mandatory service charges

(Muradian et al., 2010). Also, it has been argued that physical characteristics of resources for generating ecosystem services can in some instances determine types of payments either voluntary or coerced through taxation (Farley et al., 2010; Kemkes et al., 2010). For example, services dominated by private good characteristics are amenable to voluntary payments, while services with public good characteristics such as carbon sequestration are not (Kemkes et al., 2010). As such, private sector firms can be reluctant to pay for ecosystem services when they believe that the provision of the service is the responsibility of the public sector to pay (Koellner et al., 2010).

In addition, the complexity of ecosystems and the services they generate suggests that Wunder's criteria about a well defined ecosystem service may not apply to all services (Rørstad et al., 2007). There are many PES programs that are paying for watershed related services despite uncertainty about the water regulation services provided by forests and other land uses (Porrás et al., 2008). In addition, in the face of ecosystem complexity, payments for a bundle of loosely defined services are likely to maximize societal benefits and reduce transaction costs that can increase as services are explicitly defined (Rørstad et al., 2007).

Furthermore, Wunder's definition relies on the Coasean conceptualization of markets in which private market negotiations among social actors are considered to lead to an optimal allocation of resources regardless of initial allocations since the beneficiary of services will compensate the provider for the externality (Coase, 1960). This conceptualization leads to subdividing PES into PES-core programs, PES-like programs and other financial or market based conservation

approaches on the basis of the extent to which they fulfil the five criteria stated in the definition (see Figure 2.3). PES-core programs as proposed by Wunder (2005) requires strict PES set up that the program should firmly comply with the five requirements of the definition that are voluntary transaction between a minimum one buyer and minimum one seller of a well defined ecosystem service and with a strong conditionality attached. However, many of the conservation instruments or initiatives referred to as PES in the literature do not comply with all of the five requirements and therefore are characterised as "PES like" programs (Jack et al., 2008; Zandersen et al., 2009). These programs may not have buyers paying voluntarily for the service or other programs may only have a low conditionality implemented or have a weak conditionality. Figure 2.3 illustrates the gradient between PES-core programs that comply with the five criteria to the PES-like programs that meet some of the criteria and in periphery other economic incentives such as reforestation subsidies and salaries for nature reserve guardians (Wunder, 2008b).

In an attempt to encompass real life PES programs, Sommerville *et al.* (2009: 2) define PES as *"approaches that aim to (1) transfer positive incentives to environmental service providers that are (2) conditional on the provision of the service, where successful implementation is based on a consideration of (1) additionality and (2) varying institutional contexts"*. In addition, Muradian *et al.* define PES as *"a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources"* (2010: 1205). These definitions focus on the public good character of most ecosystem services and

the resulting externalities internalized within PES. They also include governmental payment programs, which frequently represent a Pigouvian conceptualization of PES (Vatn, 2010). This conceptualization emphasises that negative externalities should be taxed while positive ones are subsidized (Van Hecken and Bastiaensen, 2010).

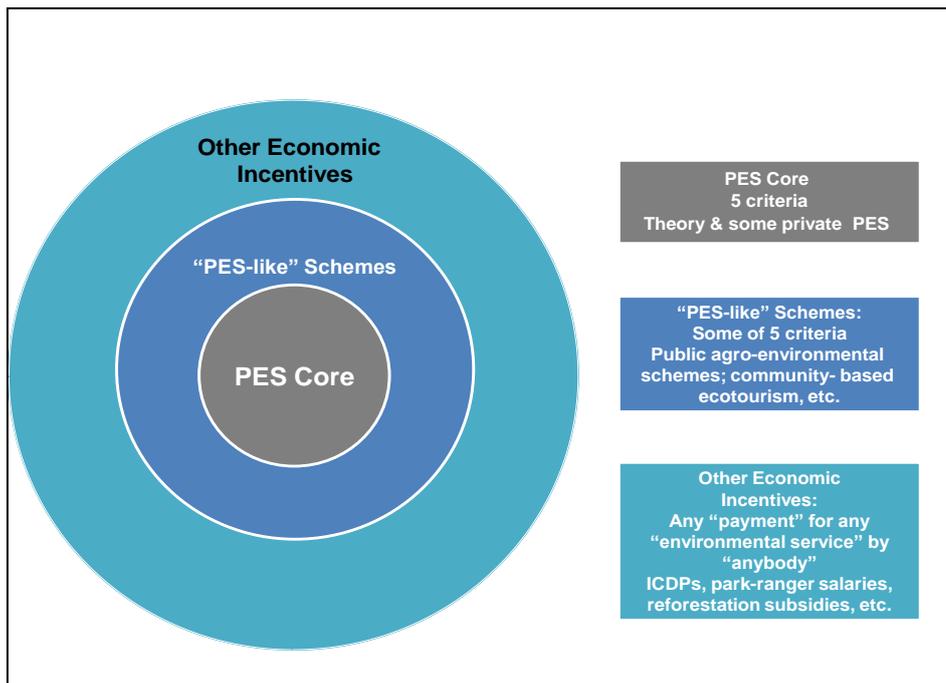


Figure 2.3. PES definitions -- between hardcore and periphery
Source: (Wunder, 2008b)

2.3.4 Implementation of PES Programs

Globally, there are numerous PES initiatives being implemented at varying scales, ranging from local initiatives for conserving watersheds to regional and global arrangements for biodiversity and carbon sequestration services (Landell-Mills and Porras, 2002; Corbera et al., 2007; Wunder et al., 2008). Other initiatives are for landscape beauty and for bundles of several ecosystem services (Landell-Mills and Porras, 2002). In their assessment of PES programs around the world, Landell-Mills and Porras (2002) identified about 300 programs.

Many other programs have been established since then (Wunder et al., 2008; Schomers and Matzdorf, 2013). With regard to the geographical distribution of PES, the review by Schomers and Matzdorf (2013) which compares developing and developed countries PES research (in terms of the continents and countries where PES case studies and basic research have been conducted), shows that geographical distribution of PES studies is inclined to developing countries in general and Latin America in particular (Figure 2.4).

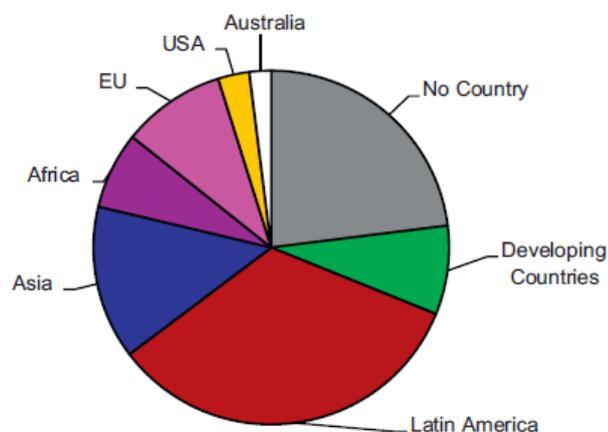


Figure 2.4. Geographic distribution of overall PES publications (n=457).
Source: Schomers and Matzdorf (2013)

Reviews of PES programs in both developing and developed countries show that, PES programs can be differentiated as government financed (this may include third-parties such as non-governmental organisations (NGOs)) and user-financed PES programs, and use-modifying in agro-ecosystems and use-diverting in forest ecosystems (Wunder et al., 2008; Schomers and Matzdorf, 2013). According to Wunder *et al.* (2008: 834), these differences in PES programs reflect the adaptation of the basic PES concept to varying ecological, socioeconomic or institutional conditions. The difference between user-financed and government-financed PES programs is significant (Wunder et al., 2008). In the former, funding

comes from the users of the ecosystem services while in the latter it comes from a government, also referred to as a third party (Wunder et al., 2008: 835).

User-financed PES programs reflect the Coasean conceptualization of markets (Schomers and Matzdorf, 2013) which states that given low to no transaction costs and clearly defined and enforceable property rights, no governmental authority is needed to overcome the problem of internalizing external effects (Coase, 1960). Rather private 'market negotiations' among social actors will lead to an optimal allocation of resources regardless of initial allocations, because the beneficiary of services will compensate the provider for the externality (Coase, 1960). According to Coase (1960), governmental intervention will not perform better or produce more efficient outcomes than leaving the distribution of resources to the market. Government is only required to allocate initial property rights and to warrant legal environment where property rights are enforceable.

In contrast, government financed PES programs mirror the Pigouvian philosophy of taxing negative and subsidizing positive externalities (Van Hecken and Bastiaensen, 2010). According to the classical Pigouvian philosophy, payments (i.e. tax or subsidy) should be equal to the marginal net benefit or costs to be generated or avoided. As such, environmental pricing begins with a predetermined set of standards for quality and then unit taxes (or subsidies) sufficient to achieve these standards are imposed (Baumol and Oates, 1971: 51). However, the Pigouvian philosophy in PES is divergent from the classical Pigouvian subsidies because the payments in PES are not necessarily linked to a commodity assumed to provide a beneficial externality (Van Hecken and

Bastiaensen, 2010). Rather, ecosystem services are converted into a tradable commodity (Kosoy and Corbera, 2010; Van Hecken and Bastiaensen, 2010) and the state acts as a third party on behalf of actual service users or buyers (Engel et al., 2008).

The main difference between user-financed and government financed PES programs is the directness of transfers whereby in the former, direct users pay the service providers while in the latter, buyers are not the direct users. In the user-financed PES programs, service users pay landholders for the provision of ecosystem services characterized as club goods. Also, the users of such ecosystem services exist only at local scales and can be directly identified (Vatn, 2010). On the other hand, government financed PES programs are focused on the provision of public goods in which the users of the ecosystem service cannot be excluded at all or at reasonable costs (Vatn, 2010). Examples of government financed PES programs include programs such as the U.S. Conservation Reserve Program (CRP) (Claassen et al., 2008) and the PSA program in Costa Rica (Pagiola, 2008) which are typically large and national-scale initiatives that embrace multiple services and political side objectives such as carbon schemes.

When compared to government-financed PES programs, user-financed PES programs are considered more efficient both economically and environmentally (Engel et al., 2008). They are likely to be efficient because service buyers are directly involved and thus are informed about the value of the service (Engel et al., 2008). Also, they have clear incentives to ensure the functioning of the mechanism. In addition, service users can directly observe whether the service is

being delivered, and if needs arise they can re-negotiate (or terminate) the agreement (Engel et al., 2008). Wunder et al. (2008) describe user-financed PES programs as fully voluntary to ecosystem service providers and to users who enter and exit contracts voluntarily. In contrast, government financed PES programs are only voluntary on the providers' side (Wunder et al., 2008). User-financed PES programs have been described as better targeted, more tailored to local conditions and needs, have better monitoring, enforcement, and more focused objectives than government financed programs (Wunder et al., 2008). Often, user-financed PES programs are small to medium size, which buy just one or two services, involve single private-sector buyers, and are more targeted in design (Wunder et al., 2008). Examples of user-financed PES programs include programs such as the Pimampiro and PROFAFOR in Ecuador which target watershed protection and carbon sequestration respectively and Vittel in France which target water quality provision (Perrot-Maitre, 2006).

Another category of PES programs is use-modifying in agro-ecosystems (active or working agricultural land) and use-diverting in forest ecosystems (use-restricting programs) (Wunder, 2007; Zilberman et al., 2008; Wunder and Börner, 2011a). Use-diverting programs are those programs where lands are diverted from agricultural production to other uses, while use-modifying programs are those where lands remain in agriculture but production activities are modified to achieve environmental objectives (Zilberman et al., 2008). Use-diverting programs aim at *“reducing agricultural expansion and encouraging cropland retirement and forest conservation”*; while use modifying programs aim at *“changing agricultural technologies and practices”* (Wunder and Börner, 2011a: 278). In this context, use-diverting PES programs

compensate farmers for suspending environmental degrading activities while use-modifying programs change environmental degrading activities without scaling back economic output (Zilberman et al., 2008; Wunder and Börner, 2011a).

Table 2.4 shows the distinction between use-diverting/restricting and use-modifying programs within the context of forest and agriculture ecosystems (Wunder and Börner, 2011a). Conceptually, there is no full overlap between the forestry-agriculture and use-restricting - use-modifying PES distinctions (see Table 2.3).

Table 2.3. Comparison between use-diverting and use-modifying PES programs

Land-diverting/Use-Restricting	Working-land/Use-Modifying
Forest conservation, including REDD, biodiversity, water	Reduced-impact logging-forest certification Afforestation and reforestation (AR), including CDM
Agricultural land retirement	Agro forestry - silvipasture Improved agriculture(organic, no tillage, no burn, etc)

Source: Wunder and Börner (2011a: 279)

Whether PES payments to farmers are for use-diverting/restricting (i.e. conservation of pre-existing environmental services) or for use-modifying interventions (i.e. adoption of SLM practices), they are expected to result in the provision of ecosystem services and improvement of local economic activities such as employment and productivity (MA, 2005b; FAO, 2007b; Zilberman et al., 2008; Mahdi et al., 2009; Wunder and Börner, 2011a). On this topic, there are significant theoretical discussions about the potential of PES programs to achieve

poverty reduction and provide ecosystem services in developing countries (MA, 2005b; FAO, 2007b; Mahdi et al., 2009). Pagiola (2005) presents a framework of assessing the effectiveness of a PES program in achieving poverty alleviation and conservation objectives (Figure 2.5). In the process of making privately unprofitable but socially-desirable practices profitable to landholders (see case A), a PES program can experience various types of inefficiencies (Pagiola, 2005). These include (1) offering payments that are insufficient to induce adoption of socially-desirable land uses, thus causing socially-undesirable land uses to remain in use (case B); (2) adopting socially-undesirable land uses, that supply environmental services, but at a cost higher than the value of the services (case C) and; (3) paying for adoption of practices that would have been adopted anyway (case D) (Pagiola, 2005). Figure 2.5 illustrates the circumstances that determine the effectiveness of a PES program in the supply of ecosystem services and poverty reduction.

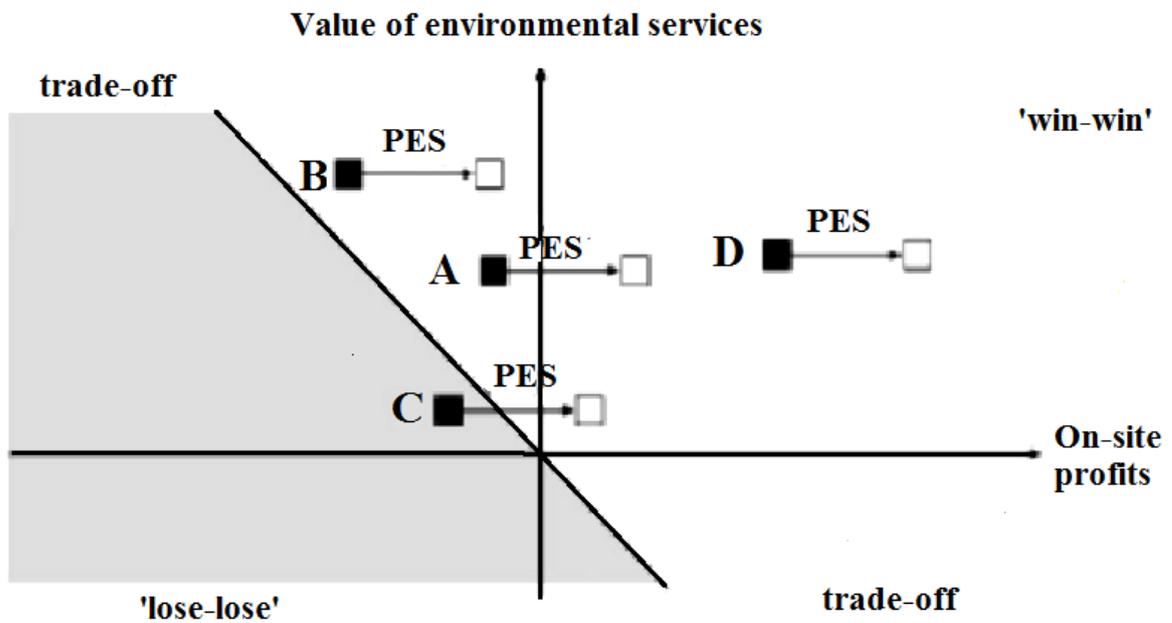


Figure 2.5. A framework to analyze the efficiency of PES. Land uses according to their net private profitability from the perspective of land users (horizontal axis) and the net value of the environmental services generated to others (vertical axis). At bottom-right, land-use practices are privately profitable but generate negative externalities; at top-left, practices are unprofitable to land users but generate positive externalities. *It is land-use practice in this last quadrant (TOP-LEFT) that effective PES programs encourage.* The 45° diagonal separates negative (below) and positive practices (above).

Source: Adapted from Pagiola (2005)

With regard to use-diverting and use-modifying PES interventions, there is a number of differences in their effectiveness in the provision of ecosystem services and achieving poverty reduction. In relation to ecosystem services, use-diverting PES programs are considered the most effective way to secure large amounts of ecosystem services, outperforming use-modifying intervention (Wunder and Börner, 2011) as they can lead to the return of native plants, wildlife habitats, and prevent erosion or air pollution (Zilberman et al., 2008). For instance, if land is diverted away from pasture, it can result in reduced animal waste runoffs that pollute local waterways and, when diverted from field crop production to forest, it can generate more carbon sequestration and biodiversity conservation. In use-

diverting programs, standing forests represent a huge carbon stock, climate regulator and biodiversity reservoir as well as providing water regulation (Wunder and Börner, 2011a). As such, it is anticipated that ecosystem service buyers are likely to prefer use-diverting programs as an option that delivers more services.

Competition between use-diverting and use-modifying PES programs is not only about the quantities of ecosystem services delivered, but also about the provisioning costs, technical complexities and spill over effects. Opportunity costs and technological complexities associated with interventions have been shown to affect use-modifying PES interventions more than use-diverting intervention (Wunder and Börner, 2011a). For example, the introduction of improved cropping techniques in use-modifying PES can privately pay for themselves through yield increases (Koohafkan and Stewart, 2008). However, farmers who are risk averse may not adopt complex technologies requiring heavy investments, maintenance and training (Mercer, 2004). In many developing countries, challenges such as opportunity costs and technological complexity are frequently reported to be off-putting to farmers who face constraints to capital, labour and know-how, and who lack a supply of new required inputs or markets for new outputs (Knowler and Bradshaw, 2007). Consequently, use-diverting programs have attracted the interest of many conservation investors as it can be much simpler to delimit a forest area as a “*no-go zone*” or to set aside a marginal production area for natural regeneration (Wunder and Börner, 2011a). Use-diverting solutions have numerically small opportunity costs and few investment costs, thus making them low-risk to adopters (Wunder and Börner, 2011a).

In addition, transaction costs in use-modifying PES programs are higher than in use-diverting programs (Wunder, 2007; Wunder and Börner, 2011a). Often, high transaction costs in use-modifying PES are associated with the costs of organising service providers in prime agricultural areas often with higher population densities than in forest margins. In addition, costs of monitoring compliance are higher in these landscapes where remote sensing is less feasible and ground monitoring of active implementation of practices such as no-tillage farming, terracing, and mulching is necessary (Wunder, 2007). Despite these challenges, it has been shown that land tenure in consolidated agricultural areas is more secure than in forest frontiers.

In use-modifying interventions, conservationists tend to argue that introduction of improved agricultural practices can create positive spill over effects on the environment (Davidson et al., 2008). However, if improved agricultural practices are very attractive to farmers, they may use PES payments to function as a transitory adoption subsidy to actively expand the new more profitable production method into new areas, including at the cost of degradation of intact ecosystem services that would not have been disturbed (Angelsen and Kaimowitz, 2001). In this context, up-scaled adoption may create more negative spill over effects for the environment in use-modifying PES programs than in use-diverting programs. This suggests that agricultural use-modifying PES programs could become victims of their own success, at the cost of reduced environmental efficiency (Wunder, 2007). However, negative environmental spill over is not only a concern within use-modifying programs; use-diverting programs can also lead to negative spill over effects when agricultural production pressures are shifted into other

areas (leakage) especially when the program involves agricultural land retirement (Wunder, 2007; Jack et al., 2008). As such, both approaches can have negative impacts on other non-targeted services.

According to the global survey of PES programs by Landell-Mills and Porras (2002), as much as four-fifths of implemented PES programs were use-diverting forestry programs (i.e. forest conservation, including REDD, biodiversity, water). Only a couple of use-modifying agricultural PES programs were identified apart from cases such as retirement of agricultural land and introduction of agro forestry. In their review, Porras et al. (2008) showed that most PES programs in developing countries are use-diverting programs rather than use-modifying programs. Out of 50 examples of watershed PES programs reviewed in the tropics, only a handful were purely use-modifying programs (Porras et al., 2008). In the Asian review by Huang et al. (2009), the ratio was 2 to 15 while in the African review by Ferraro (2009b), there were no use-modifying programs identified.

In general, use-modifying PES programs are exclusively associated with developed countries agro-environmental schemes, such as those in the United Kingdom (Dobbs and Pretty, 2008), and the European Union (Baylis et al., 2008; Wunder et al., 2008; Schomers and Matzdorf, 2013). The French water bottler, Vittel's watershed scheme which pays for improved dairy farming and reduction of animal stocks is a good example of a use-modifying PES program in a developed country (Perrot-Maitre, 2006). Exceptional programs in developing countries include examples that incorporate agro-forestry components such as

the Regional Integrated Silvopastoral Approaches to Ecosystem Management Project (RISEMP) in Colombia, Costa Rica and Nicaragua (Pagiola et al., 2005) and, Profafor in Ecuador (Wunder and Albán, 2008). The majority of PES programs in developing countries are implemented for services nested in forest ecosystems (i.e. use-restricting PES programs) (FAO, 2007b; Wunder et al., 2008; Ribaudó et al., 2010).

2.3.5 PES and Livelihoods and Poverty

The interest in implementing PES in agro-ecosystems in developing countries in order to achieve livelihood and environmental impacts is considerable, but as yet largely unstudied (FAO, 2007b; Ferraro, 2009b; Schomers and Matzdorf, 2013). Several global reports have emphasised the potential of agro-ecosystem based PES programs for the provision of ecosystem services. For example, the report titled the State of Food and Agriculture - Paying Farmers for Environmental Services (FAO, 2007b) and the MA (2005b) show that the potential of agro-ecosystems to enhance the provision of ecosystem services is considerable. In addition, reports such as the Water for Food, Water for Life - Comprehensive Assessment of Water Management in Agriculture, (Molden, 2007) and Livestock's long shadow: environmental issues and options (Steinfeld et al., 2006) demonstrate the trend of ecosystem degradation, the consequences of continued degradation and potential of PES to sustainably manage ecosystem services. These reports suggest that it is important to invest in PES to improve land management practices to sustainably enhance the supply of ecosystem services and poverty reduction.

The potential to enhance the provision of ecosystem services and poverty reduction through agricultural change remains widespread (MA, 2005a; FAO, 2007b; Liniger et al., 2011). Agricultural use modification in Latin America, Asia, and Africa is estimated to contribute to the reduction of carbon emissions of over 39 MtC (megatons of carbon) annually (Niles et al., 2002). Also, the global largest water users and land use changes in agriculture are said to improve water quality and quantity (Viala, 2008) and enhance biodiversity conservation and landscape beauty (FAO, 2007b). The adoption of use-modifying practices such as agro-forestry farming systems, construction of terraces, afforestation and grass strip farming through PES programs in agro-ecosystems are anticipated to contribute to poverty reduction (Liniger et al., 2011). In this way, they can bring 'win-win' impacts by generating profits to land users while generating ecosystem services (Wunder, 2008a; Zilberman et al., 2008; Branca et al., 2011; Lopa et al., 2012).

In many developing countries, agricultural lands managed by the poor (i.e. low-income people) are often located at the margins of biodiversity rich areas and on steep slopes in watersheds (Adams et al., 2004; FAO, 2007b; Bulte et al., 2008; Branca et al., 2011). For example, Nelson and Chomitz (2007) show that in Honduras and Guatemala, about 70% of areas in 77 most sensitive watersheds explored were inhabited by the poor. Paying farmers like these to adopt sustainable land management (SLM) practices has the potential to enhance the provision of ecosystem services and improve their livelihoods (FAO, 2007c; Bulte et al., 2008; Corbera et al., 2009; Branca et al., 2011). In Costa Rica, some of the

GEF-financed payments under the eco-market programs were implemented in areas inhabited by the poor (World Bank, 2000).

However, even if a PES program is implemented in areas with high poverty, it does not necessarily follow that the payments will be received solely by the poor (Pagiola et al., 2005). Even in a watershed with high poverty rates some land users are likely to be better off and, depending on the definition of poverty; there might be substantial variation in the levels of poverty among the poor. In addition, PES payments are for undertaking altered land use activities; thus payments are for the landholder (Wunder, 2005; Engel et al., 2008). As such, distribution and ownership patterns of land can greatly influence the impact of PES on poverty reduction (Pagiola et al., 2005; Pagiola et al., 2008; Pagiola et al., 2010). Transaction costs (Pagiola et al., 2008), land tenure, land holding size (Pagiola et al., 2005; Zbinden and Lee, 2005) and access and availability of credit facilities (Pagiola et al., 2005) can all influence the ability of farmers to adopt SLM practices thus affect the achievement of poverty reduction and environmental conservation objectives (Kosoy et al., 2008; Azizi Khalkheili and Zamani, 2009; Koellner et al., 2010). These challenges are widely reported for other conservation approaches which consider conservation and development objectives in developing countries. This suggests that research on the livelihood and environmental impacts of PES programs cannot be overemphasised.

While interest in achieving poverty reduction through PES is considerable and conservation and poverty reduction objectives in developing countries cannot be separated (Djamhuri, 2012), it has been argued that the implied targeting that

comes with a focus on poverty reduction can increase transaction costs and decrease the level of provision of ecosystem services (Ferraro, 2002; Wunder, 2005; Ferraro, 2009b). This argument raises a key question as to whether PES can achieve both conservation of ecosystem services and help the reduction of poverty in developing countries (Adams et al., 2004; Barrett et al., 2005; World Bank, 2005). This is an important question particularly in Africa where the focus on poverty alleviation is one particular vital element of existing and proposed PWS initiatives (Ferraro, 2009b; Stanton et al., 2010; Bennett et al., 2013). In the review of African PWS, Ferraro (2009b) argues that poverty reduction in Africa is valuable, or more valuable, than the watershed services that these payments target. Whether PWS can have a large impact on poverty alleviation remains to be seen. While there is considerable lack of evidence, the appeal of PES programs which provide employment and other livelihood benefits may explain the African interest in the potential role of PES to restore degraded ecosystems (Ruhweza and Masiga, 2005).

2.3.6 Development of PWS Programs in Africa

In Africa, the number of PWS programs that are focused on poverty alleviation alongside the supply of ecosystem services through improved land use (i.e. land modifying PES programs) has been increasing. In 2011, six active programs of PWS were identified in eastern and southern African countries (Table 2.4) (Bennett et al., 2013). As in programs in other developing countries such as the RUPES program in Asia established to reward the poor for ecosystem services (Rosales, 2003) and the World Bank supported PES programs in Latin America

(Scherr et al., 2003), one of the common elements across the diversity of PWS programs in Africa is the strong integration of the social component of poverty alleviation (Stanton et al., 2010; Bennett et al., 2013). For example, the Working for Water (WfW) program employs nearly 30,000 people through funds from the South African government's poverty relief fund as well as water use fees from households and foundation support (Turpie et al., 2008; Bennett et al., 2013). Table 2.4 shows active PWS programs in Eastern and Southern Africa.

Table 2.4. Active PWS Programs in Eastern and Southern Africa

	Country	Payer type	Payment	Co-Benefits	Activity
Lake Naivasha Watershed Management Project	Kenya	Beneficiary pays	Cash, In-kind	Biodiversity, Landscape beauty	agricultural best management practices and protection of riparian areas
Working for Water	South Africa	Public good payer	Cash, In-kind	Biodiversity, Carbon sequestration, Landscape beauty	Removal of invasive plants is the focus of efforts.
Cape Town City Council Water Balance Programme	South Africa	Beneficiary pays	Cash	Biodiversity	
Uluguru Mountains	South Africa	Polluter pays	Cash	Biodiversity	
	Tanzania	Beneficiary pays	Cash, In-kind	Carbon sequestration	changing land-use practices, including implementing agroforestry and limiting erosion, as well as riparian rehabilitation
Uganda Breweries/National Wetland Programme	Uganda	Polluter pays	Cash	Biodiversity	A brewery pays for wetlands protection as a pollution filtration strategy

Source: Adopted from Bennett et al. (2013: 17)

In addition to poverty alleviation goals, PWS programs in Africa are characterised by investments to improve the capacity of local communities and institutions by identifying, formulating and implementing integrated ecosystem management activities at micro-catchment level (Ferraro, 2009b; German et al., 2010; Jindal, 2011; Bennett et al., 2013). This in many cases involves the establishment of

community leadership structures (at micro-catchment level) to co-ordinate the implementation of ecosystem management interventions and the provision of in-depth training to better ensure long-term sustainability of the established micro-catchment management system (Stanton et al., 2010).

Another common element of PWS programs in Africa is the tendency not to monitor the actual change in water quality or quantity (Stanton et al., 2010; Bennett et al., 2013). They instead verify and reward the adoption of land management options that are likely to deliver the expected ecosystem services (Stanton et al., 2010; Lopa et al., 2012). For example, in Kenya's Lake Naivasha basin, a consortium of large-scale horticulture operations, ranchers, and hotel owners near the lake are providing farmers with vouchers for agriculture inputs in substitute for implementing practices that can decrease farm run-off, which damages irrigation systems and harms biodiversity and landscape beauty (Nyongesa, 2011; Willy et al., 2012; Bennett et al., 2013). Another example is the Equitable Payments for Watershed Services Program in Tanzania where farmers are paid for the adoption of SLM practices such as terraces and agro-forestry (Branca et al., 2011; Lopa et al., 2012).

These examples illustrate one of the important PES design considerations where payments can be for the service itself or for some actions believed to increase environmental services when the action can be specified at an appropriate level (Gibbons et al., 2011). Payment for service itself is considered effective for services that can be measured easily and the cause-and-effect linkages are straightforward such as carbon sequestration services. Payments for actions are

effective when it is difficult to establish the links between cause and effect in service provision (FAO, 2007b; Gibbons et al., 2011). One example of this is payments for watershed services which are characterized by complex hydrological links between cause and effect in service provision (FAO, 2007b). As such, payments for watershed services are more easily linked to observable land-use changes that are associated with changes in the provision of the desired service (FAO, 2007b; Gibbons et al., 2011). In general, paying for agricultural practices that are likely to result in enhanced service provision can be more cost-effective when costs of measuring the service or to monitor compliance are high (FAO, 2007b).

The development of PWS programs in Africa, however, struggles to secure upfront capital for design and implementation, and long-term funding for operation (Ferraro, 2009b). This struggle is partly associated with difficulties in finding willing and able buyers of ecosystem services (Waage et al., 2006; Ferraro, 2009b) and poor institutional and regulatory frameworks which stand in the way of compensation for watershed services. For example, four out of ten active programs identified in 2010 and three out of five programs developed in 2010 were no longer in operation as they had been abandoned by 2012 (Bennett et al., 2013). According to Turpie et al. (2008), the survivability of the two existing PWS programs in South Africa is due to their reliable financing sources (which are the government general tax revenues) and a strong program emphasis on economic empowerment and poverty alleviation rather than ecosystem services.

Lack of information and familiarisation with PES mechanisms constrains demand for watershed services even when water scarcity and water quality are important issues in many Africa cities (Ferraro, 2009b). Associated with this is the lack of capacity to design and implement PWS programs which is considered a critical barrier to the development of PWS programs in Africa (Ferraro, 2009b). In addition, the development of PWS programs in Africa is constrained by the poor financial state of institutions which could potentially be the source of payments for services (Ferraro, 2009b). These include large industrial users, hydroelectric power suppliers, irrigation water users, municipal water suppliers and general tax revenues (Ferraro, 2009b; Bennett et al., 2013).

Furthermore, high transaction costs can hinder the development of PWS programs in Africa (Ferraro, 2009b). Due to high population densities in most rural agro-ecosystems, PWS programs would have to contract with a large number of small landowners or users suggesting that the costs of making and enforcing contracts could increase transaction costs (Jack et al., 2008). Also, regulatory environments, rates of literacy, judicial systems, little information as well as lack of trust and corruption can increase transaction costs (Ferraro, 2009b).

Land tenure has been indicated as an important barrier to PWS development in Africa. Most lands are held under customary tenure systems that provide access to all recognised members of the community; hence PWS programs could frequently have to address multiple sources of formal and informal authorities over a given track of land (Bennett et al., 2013). Also, in some societies, customary tenure system do not permit land sales particularly to persons outside

the community and leasing can be complicated by tenure insecurity and increased rental rates (Lastarria-Cornhiel et al., 1999; Agrawal, 2002).

Although PWS has received considerable interest in Africa, the empirical evidence of their effectiveness in increasing the production of ecosystem services (Wunder, 2007; Jack et al., 2008) and in poverty reduction remains sketchy in agro-ecosystem based programs (Wunder, 2008b; Ferraro, 2009b; Schomers and Matzdorf, 2013). Studies that have investigated livelihood impacts of PES programs have mainly concerned carbon related programs. Some have reported positive impacts on the livelihoods of people including a study by Tipper (2002), which suggested that the Scolel Te project in Mexico had a positive effect on household incomes in the project area. Another study by Wunder and Alban (2008) found that the PROFAFOR carbon project in Ecuador had increased household incomes in addition to investing in educational and development infrastructure in the area. This study however reported that individual carbon contracts were signed only with landholders owning at least 50 hectares of land to limit transaction costs. As such, it left behind those landholders with less land i.e. mainly the poor. In addition, a study on the Humbo project in Ethiopia suggested that local communities were benefiting from the project activities, and anticipated significant influx of capital into the area in the form of carbon payments (Brown et al., 2011).

A study by May et al. (2004) on four carbon projects in Plantar, Peugeot, and Bananal in Brazil, and Noel Kempff in Bolivia, concluded that even though these projects had generated some development benefits, the top-down approach and

slow adoption of appropriate land use systems led to negative livelihood impacts in the area. Comparable views have been echoed by Asquith et al. (2002), who found that the Noel Kempff project had a mixed effect, with some stakeholders benefiting from the program activities while a large proportion of community members expressed dissatisfaction with the project due to its negative impact on their livelihoods because of the loss of their traditional land (the forest) into the park expansion zone. This forest was their main source of cash income from rubber exploitation, through hunting and logging (Asquith et al., 2002).

Increasing numbers of scholars have raised alarms about the neoliberalization of environmental governance. They show that the outcomes of a number of implemented 'neoliberal conservation' programs have included elite capture of resources that were designed to go to the poor (Robertson, 2004; Kosoy and Corbera, 2010; Pascual et al., 2010). This presents a counterpoint to the optimistic scenario of PES as a panacea. Some programs are benefiting elites because they are structurally skewed against the abilities of local poor (Kosoy and Corbera, 2010; Pascual et al., 2010). The only way that a household can gain net financial and other benefits is when they have enough assets to effectively participate in schemes in addition to favourable program design and institutional conditions (Jindal et al., 2008; Wunder, 2008b; Zilberman et al., 2008).

Many PES systems in the tropics have been open to landowners whose lands meet basic criteria. Often, they favour those who control large portions of land with title deeds who are likely to be wealthier and well-educated, able to absorb

transaction costs and privy to the advertisement of the programme (Miranda et al., 2003; Zbinden and Lee, 2005). These issues have been demonstrated in a number of studies. For example, land title requirements to subscribe in the Costa Rican PES program excluded poorer farmers with customary rights which limit the potential for prioritisation of participation of poor individuals within the PES scheme (Pagiola et al., 2002). In Zimbabwe, elite capture is widely thought to be the primary reason for the collapse of the flagship CAMPFIRE initiatives (Balint and Mashinya, 2006; Nelson, 2012). Also, in the Nhambita project, elite capture by male-headed and high-income households has been reported whereby the poorer households delayed participation until they saw positive program results (Hegde, 2010).

These studies show that PES programs have had a mixed effect on local populations and that the debate over whether or not they help alleviate poverty and provide ecosystem services is far from settled. Indeed, there are concerns regarding the extent to which local poor and smallholders are able to participate in PES programs (Uchida et al., 2007; Pagiola et al., 2008). Poor households may be unable to participate in PES due to insecure tenure, insufficient land to set aside for PES activities, high transaction costs, or high upfront investments needed to adopt new land use practices (Jindal et al., 2008). Also relevant for agro-ecosystem PES programs are the factors that affect small landholders' adoption of new agricultural technologies such as secure tenure, access to technical assistance, and availability of savings to meet investment and maintenance costs (Chapter 4) (Mercer, 2004). In some PES studies, researchers have found that poor households are able to participate (Pagiola et

al., 2008), while in others, participation seems to have been limited to relatively well-off and elite landowners (Miranda et al., 2003). As such, researchers have pointed out a clear need to conduct more investigations into livelihood outcomes and impacts of PES programs in addition to their effectiveness or outcomes and impacts on the provision of ecosystem services (Engel et al., 2008; Corbera et al., 2009).

While concerns regarding impermanence and leakage in conservation programs have been expressed widely in conservation literature (Wunder, 2005), documentation on actual field experience is limited on agro-ecosystem PES programs in developing countries (Jindal, 2006; Wunder and Albán, 2008; Jindal et al., 2010). These gaps are disconcerting given the rapid increase in the number of PES programs and plans to invest billions of dollars in activities aimed at enhancing provision of ecosystem services such as water regulation and carbon sequestration services in developing countries (Miles and Kapos, 2008). These issues make it vital to evaluate assumptions about what happened to the ecosystem services and livelihoods of program participants with PES intervention against without PES intervention (detailed review of these and assessment is in chapters 5 and 6).

2.4 Evaluating Payments for Environmental Services

According to Leeuw and Vaessen, impact evaluation is the assessment of *“the positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended”* (Leeuw and Vaessen, 2009, p.ix). The enthusiasm for impact evaluation in conservation

is linked into weak evidence base concerning the impacts of various interventions such as the impacts of protected areas and community forest on environmental conservation and poverty reduction (Andam et al., 2008; Ferraro, 2009a; Pattanayak et al., 2009; Andam et al., 2010; Pattanayak et al., 2010). Knowledge on the performance of market based conservation intervention like PES programs on what works and does not work is vital to the public, conservation practitioners and policy makers to improve their conservation decisions in the midst of scarce conservation funds (Ferraro and Pattanayak, 2006; Vaessen et al., 2007; Margoluis et al., 2009).

In order to capture what works and what does not work, methods from development economics, education and public health that are widely attributed to the transformation of these fields offer opportunity for conservation field to adopt them conducting rigorous impact evaluation of conservation interventions (Glewwe and Kremer, 2006; Glewwe et al., 2011). These methods assess counterfactual effects of an intervention by determining what would have happened in the absence of it (Ferraro and Pattanayak, 2006; White, 2006; Ferraro, 2009a; White, 2009). Approaches that are widely considered rigorous to assess counterfactual outcomes or impacts of an intervention include those that employ experimental and quasi-experimental research design (Baker, 2000; White, 2006; White, 2009; Bamberger et al., 2010). Experimental research design relies on data obtained from randomly assigned subjects into treatment and control groups and collected before and after intervention (White, 2006; White, 2009; Khandker et al., 2010). Both treatment and control groups are randomly eligible sample units. Control group which did not receive treatment is used as a

counterfactual or comparison group for treated since its characteristics are assumed to be not systematically different from treated group (White, 2009; Khandker et al., 2010). Experimental design is widely regarded as the gold standard for intervention evaluation. However, while their design presents strong evidence for causality and strong internal validity; often, it is not practical due to ethical issues, high implementation costs and weak external validity such that the findings cannot be generalized to other settings due to the artificial settings in which experiments are implemented (Vaessen et al., 2007; Margoluis et al., 2009).

Quasi-experimental research design is the second-best option for conducting impact evaluation when randomization of treatment is impossible. It relies on observational data from units exposed to intervention and units not exposed to intervention (with-without approach) or from data collected before intervention and after intervention (before-after approach) (Khandker et al., 2010). Before-after and with-without quasi-experimental designs are commonly used in the field of conservation policy (Ferraro and Simpson., 2002; Pagiola, 2005; Ferraro and Pattanayak, 2006; Pattanayak et al., 2009; Khandker et al., 2010; Brown et al., 2011). However, these methods are considered inadequate due to time trend biases for before-after comparison, and selection bias for with-without comparison (Margoluis et al., 2009; Khandker et al., 2010). Statistical methods such as difference - in - differences estimation or propensity score matching techniques are used to create comparison groups that are bias free (Ho et al., 2007; Margoluis et al., 2009; Austin, 2011). Compared to experimental design, quasi-experimental research design is easier to establish and able to generate

results with moderately high external validity that permits some generalizability of findings (Vaessen et al., 2007; Margoluis et al., 2009).

Frequently, findings in terms of mean differences from studies (i.e. environmental impacts) which use rigorous quasi-experimental research design (i.e. with appropriate counterfactual) are not significantly higher than might have been when inferred from simple comparisons with inappropriate counterfactual group such as comparison areas or non-treated groups that are different from treated areas or groups (Joppa and Pfaff, 2011). Often, high impacts are reported for studies that do not control selection bias caused by non-random factors such as those which influence selection of areas where interventions are implemented, or group assignment or sign up to participate in programs. For example, treatment areas such as protected areas may be located in more remote areas away from roads, in higher elevations or on soil types that are marginal for agriculture or population centres (Andam et al., 2008; Pfaff et al., 2008; Joppa and Pfaff, 2010; Joppa and Pfaff, 2011). Due to these aspects, treatment areas would be expected to have lower deforestation rates regardless of the protected area intervention itself (Joppa and Pfaff, 2011).

In addition, experimental and quasi-experimental research design encounters spill over effects when the direct or indirect effects of the intervention leaks over from the treatment group into the control. Also, they can lack compliance from intervention implementing agency that might compromise the study due to the fear of finding negative impacts or inadequate positive evidence which might jeopardise future support for funding (Chen et al., 2009; Prowse and Snilstveit,

2010). Furthermore, while experimental and quasi-experimental design can rigorously generate evidence of the effectiveness of an intervention, they are less able to tell why and how intervention works or does not work and under what circumstances in order to inform improvement or revisions (Bamberger et al., 2010). To address these concerns, quantitative methods need to be combined with qualitative methods that are able to explain questions that cannot be answered by experimental and quasi-experimental methods.

Evaluation studies that use qualitative evaluation design focus on sampling framework and not on how exposed and non-exposed subjects compare (Vaessen et al., 2007; Margoluis et al., 2009). Frequently, stratified purposeful sampling method is used whereby subjects that vary according to some dimensions are sampled within stratified samples to facilitate comparison (Margoluis et al., 2009). Another qualitative sampling method is extreme or deviant case sampling for the purpose of learning from highly unusual issues of interest such as outstanding success and notable failures (Margoluis et al., 2009). Theory based or operational construct sampling is another qualitative sampling method which sample subjects on the basis of their potential manifestation of theoretical construct so as to elaborate and examine constructs (Margoluis et al., 2009).

2.5 Synthesis and Conclusions

This literature review has demonstrated that, ecosystem services including agro-ecosystems which are directly managed by humans for food, fibre and fuel production supply provisioning, regulating and cultural services while at the same

time demand supporting services such as water and fertile soils to enable them to be productive (MA, 2005a; FAO, 2007a). However, degradation of ecosystem services from many of the World's ecosystems, including agro-ecosystems have increased at an alarming rate (MA, 2005a; FAO, 2007b). Also, the literature shows that challenges such as knowledge gaps, opportunity costs related to land and adoption input costs such as labour and fertilizers or manure impede the uptake of SLM practices in developing countries (Liniger et al., 2011).

Payments for ecosystem services programs in agricultural lands are being implemented with the hope of rewarding conservation and overcoming the barriers to adopting SLM practices by providing financial support and technical assistance (Branca et al., 2011) in order to provide ecosystem services such as water quality and quantity and to achieve poverty reduction in developing countries (FAO, 2007b; FAO, 2007a; Wunder et al., 2008; Branca et al., 2011). The literature also shows that the geographical distribution of PES research is inclined towards use-diverting PES programs in developing countries and Latin America in particular (Schomers and Matzdorf, 2013). Use-modifying PES programs and thus research on the subject is exclusively associated with developed countries' agro-environmental schemes (Baylis et al., 2008; Dobbs and Pretty, 2008; Schomers and Matzdorf, 2013).

The literature further shows that the majority of existing impact studies rely on anecdotal evidence or on information gathered only from participating households, which may be biased and thus cause incomplete assessment of PES programs (Ferraro and Simpson., 2002; Pagiola, 2005; Ferraro and

Pattanayak, 2006; Pattanayak et al., 2009; Brown et al., 2011). Most studies do not differentiate impacts of PES programs from the impacts of other development components when measuring their impacts in the delivery of ecosystem services and poverty reduction (Asquith et al., 2002; Jindal, 2006; Asquith et al., 2008; Engel et al., 2008; Wunder and Albán, 2008; Jindal et al., 2010). These gaps are disconcerting given the rapid increase in the number of PES programs and plans to invest billions of dollars in activities aimed at enhancing provision of ecosystem services such as water regulation and carbon sequestration in developing countries (Miles and Kapos, 2008). As such, there has been great interest in assessing key baseline assumptions about what would have happened to ecosystem services and livelihoods of program participants and non-participants without PES intervention.

This thesis addresses some of these research gaps through a detailed investigation of the Equitable Payments for Watershed Services (EPWS) program located in Morogoro region in Tanzania, which pays landholders for adopting SLM practices such as construction of terraces, agro forestry and reforestation activities to provide water services and poverty alleviation. The research focuses on the participation of poor people in the program, determinants of program participation, impacts on the livelihoods of the program participants and on non-participants, and impacts on the provision of ecosystem services with particular focus on the additionality effects, leakage effects, permanence of adopted SLM activities and cost effectiveness in providing services. The most novel contribution of this research is that it presents findings on the impact of a PES program which makes conditional payments on a use-modifying agro-ecosystem

PES program and which also extends development benefits to landholders in a developing country. Research gaps are addressed by integrating qualitative and quantitative approaches in a quasi-experimental research design to assess the determinants of landholders' participation in an agro-ecosystem based PES program as well as associated livelihood and environment outcomes.

Chapter 3: Research Design, Methods and Study Site

3.1 Chapter Outline

This chapter presents the research design and methodology. It is divided into four main sections. In section 3.2, research design is described, which covers the explanation of the case study approach used for the research and the rationale for the selection of the study sites as well as the evaluation design. Section 3.3 describes research methods, which include descriptions of the mixed methods approach applied in this thesis (3.3.1), data collection methods (3.3.2), research phases (3.3.3), household surveys (3.3.4) and the wealth ranking approach (3.3.5). The section also covers sampling (3.3.6), interview procedure (3.3.7), semi-structured key informant interviews (3.3.8), focus group discussion (3.3.9) fieldwork observations (3.3.10) and field experience (3.3.11). Section 3.3.11 explains the recruitment and management of research assistants, the field approach and introduction, language, positionality and reflexivity, and case study ethical considerations. Section 3.4 describes the approaches used for the analysis of quantitative and qualitative data. Study site and preliminary description of the study villages are described in section 3.5. Section 3.6 shows how the propensity score matching was implemented and how covariate balance for matched data was reached. Analysis in chapter 5 and 6 uses matched dataset generated through propensity score matching described in this section.

3.2 Research Design

3.2.1 Case Study Approach

A case study approach was used in this thesis to ensure an in-depth understanding of the potential of PES programs in agro-ecosystems to provide ecosystem services and achieve poverty alleviation in developing countries. A case study approach allows in-depth empirical investigation of contemporary phenomena within their real life context rather than being independent of context (Gibbert et al., 2008; Yin, 2008; Creswell, 2009: 55; Gray, 2009). While a case study design allows an in-depth study of a phenomenon, it has been criticised because of its weak external validity (Birley and Moreland, 1998). Nevertheless, the use of multiple sources of evidence enhances the validity of the findings (Flyvbjerg, 2006; Gibbert et al., 2008; Yin, 2008). Also, a case study approach can be analytically generalized from empirical observation to theory, rather than the population generalization (Gibbert et al., 2008; Yin, 2008).

As the key rationale of this study was to illuminate a detailed understanding of the potential of PES programs in agro-ecosystems to provide ecosystem services and achieve poverty alleviation, the chosen case study (EPWS program) is representative of PES in theory, closely following Wunder's (2005), Sommerville et al.'s (2009) and Muradian et al.'s (2010: 1205) conceptualization of PES. Features of the EPWS program include voluntary transactions between service buyers and service users, conditional payments upon verification of implemented SLM practice, well defined service or land use practices believed to enhance service delivery and other in-kind incentives such as extension services and training (Branca et al., 2011; Lopa et al., 2012). Because of its consistency with

the theoretical conceptualization of PES, the EPWS program bears the characteristics of a paradigmatic case. As such, the EPWS program represents a case from which much can be learnt about the determinants of landholders' participation, and livelihood and environmental impacts of an agro-ecosystems based PES program in the context of developing countries.

As illustrated in Chapter 2, studies on PES programs implemented in agro-ecosystems where the provider of ecosystem services receives payments for the adoption of land uses and practices that support those services are relatively recent in the developing world, particularly in Africa (Tacconi et al., 2010; Schomers and Matzdorf, 2013). As such, this is a critical research area because each year, hundreds of millions of dollars are invested in the conservation of ecosystem services activities, which also include the objective of poverty reduction (Ferraro, 2002; Ferraro and Simpson., 2002; Ferraro and Pattanayak, 2006; Masiga, 2011).

3.2.2 Selection of the Study Site

The EPWS program which is an agro-ecosystem based PES program in Tanzania was chosen as the case study for this thesis. A number of features made Africa and Tanzania in particular, suitable for this study. Firstly, there has been little empirical work on agro-ecosystem based PES in Africa and Tanzania in particular (Jindal et al., 2008; Ferraro, 2009b). The EPWS program was considered an appropriate case study because it promotes the adoption of sustainable soil and water conservation practices such as terracing (i.e. bench

terraces and *fanya juu*), agro-forestry, reforestation and afforestation (Branca et al., 2011; Lopa and Jindal, 2011). Secondly, as an agro-ecosystem based PES program, it has the potential to provide important information about the feasibility of agro-ecosystem/use-modifying PES programs in Africa and Tanzania in delivering ecosystem services and poverty reduction. Thirdly, the EPWS program has raised considerable interest among policy makers and conservation organisations in Tanzania for its potential to be up-scaled to other parts of the country (Lopa et al., 2012). Fourthly, the findings from this study are particularly important because the evaluation of agro-ecosystems based PES programs including the EPWS program to date lacks solid empirical evidence particularly at the household level.

3.2.3 Evaluating the Effectiveness of the EPWS Program

This thesis evaluates the effectiveness of the EPWS program on the livelihoods of the program participants and on the improvement of the downstream water quality and quantity. However, in a non-experimental (observational) study like this, the effectiveness of an intervention cannot be simply estimated by comparing the outcome of the program participants with those of the non-participants (with – without) or the outcomes of the program participants after an intervention with the outcomes before an intervention (Ferraro, 2009a; Pattanayak et al., 2010). This is not an ideal approach because there might be other factors or events that are correlated with the outcomes but not caused by the program (Ferraro and Pattanayak, 2006; Sutherland, 2008; Pattanayak et al., 2009; Chabé-Ferret and Subervie, 2010). This problem is known as a counterfactual problem which hinders robust estimation of what would have

happened to the livelihoods of the program participants and to water quality and quantity if there had been no intervention – a counterfactual condition (Ferraro, 2009a). Often, the counterfactual problem is caused by the selection and time trend biases (Greenstone and Gayer, 2009; Chabé-Ferret and Subervie, 2010). Selection bias happens when the program outcomes are measured by comparing the practices of program participants to those of non-participants while their characteristics such as agricultural practices, social and economic practices are different. On the other hand, time trend bias happens when the program impacts are measured by comparing the practices of the participants before and after the beginning of the program when the practices would have changed even in the absence of the program. Time trend bias and selection bias are illustrated in Figure 3.1.

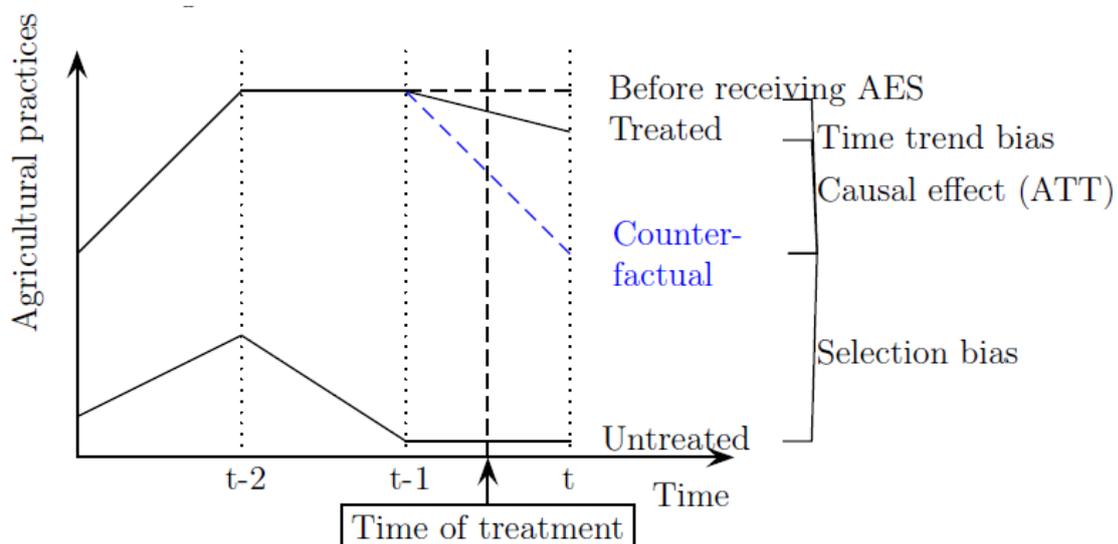


Figure 3.1. Treatment effects and selection bias (Chabé-Ferret and Subervie, 2010: 4)

To ensure methodological rigor, the estimation of the counterfactual is vital (White, 2009; Chabé-Ferret and Subervie, 2010: 2). The following quasi-

experimental cause effect model is used to ensure rigorous evaluation of the effectiveness of the EPWS program on the livelihoods of the program participants and on the water quantity and quality downstream.

As a voluntary based conservation approach that pays landowners to undertake sustainable land management (SLM) practices, the EPWS program is the type of initiative that allows livelihood and conservation outcomes to be observed from land owners who participated and from those who did not participate in the program with reference to the factors (covariates) that determined their participation. This idea is the basis of the “causal effect” model to evaluation of an intervention (Rubin, 1974; Greenland et al., 1999; Rubin, 2001; White, 2006; Ho et al., 2007; White, 2009) whereby the livelihood and conservation outcomes or impacts of an intervention like EPWS program can be derived from the differences between the potential average outcomes of program participants and non-participants. This approach is increasingly promoted as a credible approach to evaluate the treatment effects or the outcome of environmental conservation programs or intervention (Brundtland, 1987; Jumbe and Angelsen, 2006; Ferraro et al., 2007).

The causal effect model holds that the effect of a program such as EPWS program can be uncovered if the livelihood and conservation outcomes of participants are compared with the outcomes that would have resulted had they not participated in the program (Rubin, 2001; Ho et al., 2007). However, it is not possible to observe this counterfactual outcome, thus creating an evaluation problem (Rubin, 1974; Rubin, 2001; White, 2006; Ho et al., 2007; White, 2009).

This problem can be approached through the framework of a potential outcome model (POM) which assumes that every element of the target population is potentially exposed to a treatment in which the triple $(Y_{1i}, Y_{i0}, D_i, i = 1, \dots, N)$ forms the basis of treatment evaluation (Lechner and Miquel, 2001; Flanders, 2006). The categorical variable D takes the values 1 when a landowner is enrolled in the program and 0 otherwise; Y_{1i} measures the outcome (i.e. yields, expenditure, income, number of SLM practices and % of land under SLM practices) for landowner i in the program and Y_{i0} measures the outcome (i.e. yields, expenditure, income, number of SLM practices and % of land under SLM practices) when the landowner is not in the program. In addition, each landowner has a vector of characteristics, referred to as covariates or exogenous variables denoted by X_i . Given that each landowner is either a participant or a non-participant, then for each landowner the following triple attributes are observed (Y_i, X_i, D_i) , in which Y_i is the realized outcome:

$$Y_i \equiv Y_i(D_i) = \begin{cases} Y_i(0) & \text{if } D_i = 0, \\ Y_i(1) & \text{if } D_i = 1. \end{cases} \quad (6.1)$$

After the landowner has decided to enrol in the EPWS program, it will be possible to estimate the individual gain from the program which is measured by $\tau_i = (Y_{1i} - Y_{0i})$. In this ex-post evaluation of program outcomes, the fundamental evaluation problem arises because only one of the potential outcomes is observed for each entity i (i.e. yields, expenditure and income, number of SLM practices and percentage of land under SLM practices after EPWS participation or after non-participation).

Following this inherent problem, it will never be possible to estimate individual program outcomes with confidence. However, since the population averages $E[\cdot]$ of the frequency distributions of Y_{1i} and Y_{0i} can be estimated for participants and non-participants, one might still hope to be able to assess the population average of gains from the program or intervention (Pearce et al., 2003). The average causal effect of $D_i = 1$, relative to $D_i = 0$, is measured by the population average of treatment effect (ATE):

$$\tau_{ATE} = E[Y_i(\mathbf{1}) - Y_i(\mathbf{0})], \quad (6.2)$$

In this equation, the short hand notation $E[\cdot | D = 1]$ denotes the mean in the population of all landowners that participate in the EPWS program ($D = 1$) and these expectations are with respect to the probability distribution over this population of program participants¹. The symbol “|” means “conditional on.”

The average treatment effect on the treated participants (ATT) is defined as:

$$\tau_{ATT} = E[Y_i(\mathbf{1}) - Y_i(\mathbf{0}) | D = 1]. \quad (6.3)$$

The means defined in equation (6.2) and (6.3) are the most commonly-used evaluation parameters (Pearce et al., 2003; Belcher et al., 2005). However, in

¹ Distributions of (D_i, Y_i, X_i) refer to the distribution induced by the random sampling from the population.

the context of a narrowly targeted program, the sub-population of treated units (i.e. the average effect of the program on treated - ATT) is of more interest than the overall population (Belcher et al., 2005).

While this is the case, the consistent estimation of ATT is threatened by complications such as omitted variables, possible correlation between the outcomes and treatment and endogenous factors of the treatment variable when observational data generated under non-random treatment are used (Zwarteveen and Meinzen-Dick, 2001). In this context, the counterfactual mean for the program participants - $E[Y(0)|D = 1]$ - is not observed. Given this context, the choice of a proper substitute to estimate ATT is vital. Since this is an ex-post evaluation study of the outcomes of the EPWS intervention, the mean change in livelihood and land use (i.e. average number of SLM practices or the percent of land under SLM practices) of non-participants $E[Y(0)|D = 0]$ can be used. However, this is not a good idea in a non-experimental study because of the chances that the components which determine EPWS participation might also have been used to determine the properties of the land enrolled (Rosenbaum, 2002). Moreover, in a voluntary initiative like EPWS, it might be anticipated that those who volunteer differ from the wider eligible population of landowners in terms of their expected gains from the program (endogenous selection) (Rosenbaum, 2002). Some landowners may perceive greater benefits from program participation and for that reason decide to participate. Also, the targeting of certain landowners and location may lead to a self-selection bias which is not likely to be zero.

Given this situation, the basic scheme is to find ways to get rid of selection bias or to find ways to account for it to ensure sound outcomes of the study. One way would have been through randomly assigning individuals to the program, but in an observational study where assignment to treatment is not random, the use of a set of identifying assumptions (i.e. assumptions that allow the identification of the true causal effect) is vital. These assumptions include:

ASSUMPTION ONE: *Unconfoundedness assumption* also referred to as the *Conditional Independence Assumption*. Under this assumption, it is assumed that given a set of observable covariates/characteristics X which are not affected by treatment, potential program outcomes are independent of treatment assignment:

$$(Y_i(0), Y_i(1)) \perp D_i | X_i \quad (6.4)$$

The symbol “ \perp ” means “independent of.”

In this perspective, selection should be based on observable characteristics and all variables that determine treatment assignment and potential outcomes are concurrently observed (Sunderlin et al., 2005).

ASSUMPTION TWO: *Overlap or Common Support Assumption*

This assumption rules out the likelihood of perfect predictability of D given X :

$$0 < P(D = 1|X) < 1 \quad (6.5)$$

and that the probability of being both participant and non-participant is positive for people with the same X values (Nelson, 1997). This means that by combining both the unconfoundedness and overlap assumptions, the treatment assignment is strongly ignored given a vector of covariates (Nelson and Chomitz, 2004). Given this, the population average treatment effect τ can be identified by first estimating the average treatment effect for a sub-population with covariates $X = x$. This can be shown as follows:

$$\begin{aligned}
 \tau(x) &\equiv E[Y_i(1) - Y_i(0)|X_i = x] = [E[Y_i(1)|X_i = x] - E[Y_i(0)|X_i = x]] \\
 &= E[Y_i(1)|X_i = x, D_i = 1] - [E[Y_i(0)|X_i = x, D_i = 0]] \quad (6.6) \\
 &= E[Y_i|X_i = x, D_i = 1] - E[Y_i|X_i = x, D_i = 0]
 \end{aligned}$$

The second line in equation (6.6) holds because the treatment is ignored conditional on X . Now, to make the last line feasible, one needs to be able to estimate the expectations $E[Y_i|X_i = x, D_i = d]$ for all values of d and x in support of these variables. This is where the overlap assumption comes in. If this assumption is violated at $X = x$, it would be unfeasible to estimate both $E[Y_i|X_i = x, D_i = 1]$ and $E[Y_i|X_i = x, D_i = 0]$ because in those values of x there would be either only treated or only control units.

Since the interest of the study is to estimate the average effect on the treated, the unconfoundedness can be weakened in a different direction (Imbens, 2004; Abadie and Imbens, 2005). In this context one needs to assume²:

ASSUMPTION THREE: unconfoundedness for controls

$$Y_i(0) \perp D_i X_i \quad (6.7)$$

and the weaker overlap assumption

ASSUMPTION FOUR: Weak Overlap

$$P(D = 1|X) < 1 \quad (6.8)$$

Finally, to make the model's representation of outcomes adequate for causal analysis, the stable-unit-treatment-value assumption (SUTVA) also known as no-macro-effect or partial equilibrium assumption has to be satisfied for all members of the population (Rubin, 1986). This is a basic assumption of causal effect stability that requires the potential outcomes of individuals to be unaffected by potential changes in the treatment exposures of other individuals (Morgan and Winship, 2007). SUTVA is a priori assumption which states that when the value of Y for unit u is exposed to treatment t it should be the same no matter what mechanism is used to assign treatment t to unit u and no matter what treatments the other units receive (Rubin, 1986). In this context, the propensity score

² Assumption 3 and 4 are sufficient for identification of ATT because the moments of the distribution of $Y_i(1)$ for the treated are directly estimable (Imbens, 2004).

matching technique is used (Greenstone and Gayer, 2009; Chabé-Ferret and Subervie, 2010) (illustrated in section 3.8).

3.3 Research Methods

3.3.1 Mixed Method Approach

While it is possible to control biases through propensity score matching technique, it is considered difficult to fully remove them completely and be able to explain the outcomes with certainty (Baker, 2000; White, 2008; Garbarino and Holland, 2009). As such, integration of quantitative and qualitative methods would allow deeper understanding of the outcomes and impacts. By mixing methods, quantitative approaches can assess causality while qualitative methods can allow an in-depth study of selected issues to provide critical insights and the reasons behind certain results observed in a quantitative analysis (Ashley, 2000; Ashley and Hussein, 2000; White, 2008; Garbarino and Holland, 2009).

After using a mixed method approach to evaluate the impact of agricultural research in six developing countries, Meinzen-Dick et al. (2004) showed that quantitative measures of the direct impacts of new technologies on incomes and yields do not tell the whole story. The combination of both quantitative and qualitative methods plays an important role in determining whether the poor adopt new technologies and whether they receive direct or indirect benefits from new technologies. Also, mixed methods approach has been used in this thesis to benefit from the synergies of combining qualitative and quantitative methods. The usefulness of this approach has been demonstrated by many socio-economic

and poverty researchers (London et al., 2007; Place et al., 2007). For example, Place et al. (2007) show that the combination of quantitative and qualitative methods can effectively determine mean strength of relationships and strengthen the understanding of cause and effect relationships respectively. As such, a mixed methods design is used to enrich and clarify the research results by employing sequential triangulation of data during the analysis (Creswell, 2009).

In this study, a household questionnaire survey carried out for a sample of households in the study villages collected both quantitative and qualitative information. In addition, key informant interviews, focus group discussions and field observations were used to yield information relevant to the research questions and generated both qualitative and quantitative data. The following section which details data collection methods illustrates the mixing of the quantitative and qualitative methods in this thesis.

3.3.2 Data Collection

The data used for this study were collected between October, 2010 and June, 2011 from Kibungo, Lanzi, Nyingwa and Dimilo villages in the case study area in three phases. A multi-method strategy as shown above was used. A range of methods and techniques were applied in the collection of data to increase their validity and reliability for broader understanding of the research question (Johnson and Onwuegbuzie, 2004; Downward and Mearman, 2007; Gray, 2009). The use of multiple methods has been highlighted by different researchers because it is felt to improve consistency across methods through the process of

"triangulation", by looking at the problem from diverse viewpoints (Olsen, 2003; Olsen, 2004; Downward and Mearman, 2007; Denzin, 2009; Bryman, 2012). Nichols (1991) argues that even when a survey is useful, it is often best used together with other complementary methodological tools. This strategy employs qualitative and quantitative methods in three phases that are characterised by a literature review, household surveys, focus group discussions, key informant interviews and observations as detailed in the next sections.

3.3.3 Research Phases

The first phase of the research involved the use of a qualitative research design to support the inductive direction of the thesis (Shuttleworth, 2008). This phase involved a review of literature, observation of farms, focus group discussion, semi-structured key informant interviews (Bernard, 2006; Babbie, 2008) with CARE-WWF Tanzania officers administering the program, and a focus group discussion with 8 participating and non-participating farmers between October and November 2010. Material collection in this phase sought to generate grounded knowledge on elements such as targeting, eligibility rules, payments, and land change management requirements of the EPWS programme, its institutional context of implementation and the farmers' reasons for participating and not participating.

In the second phase, household surveys using a structured questionnaire were administered to EPWS program participants and non-participants. The questionnaire was tested with a small number (N=7) of households and in one

focus group meeting with village leaders in November, 2010. The main fieldwork was then conducted from March to May 2011 in four villages of Kibungo Juu ward namely Kibungo, Lanzi, Nyingwa and Dimilo. The number of households surveyed was 233 with 116 program participants and 117 non-participants. Household heads were selected from each village using stratified random sampling generated through the wealth ranking technique (see section 3.3.5), through which households were categorised into poor, middle and rich to ensure the representativeness of the sample (Chambers, 1994; White and Pettit, 2004). In the third phase, the quantitative findings arising from phase two were explored further with 32 semi-structured key informant interviews and 16 focus group discussions. The key informant interviews were conducted with CARE Tanzania EPWS program officers, village leaders, 8 representatives from EPWS groups in each program village and 8 EPWS participating and 8 non-participating households. Focus group discussions were used to capture divergent viewpoints such as the determinants of participation decisions (Hopkins, 2007). Following guidance by Hopkins (2007) and Creswell and Plano Clark (2007), participants with experience and knowledge of the phenomenon under investigation were selected. Representatives of local organizations and participating and non-participating households were selected for focus group discussions with separate focus group discussions conducted with EPWS participating and non-participating households in each program village. The size of focus group discussions was between 8-10 people. The key informant interviews and focus group discussions were conducted in 'Swahili', audio recorded and then transcribed into English.

3.3.4 Household Survey

Household surveys were conducted in the second phase of the research using a structured questionnaire administered to EPWS program participants and non-participants. This was informed by a quasi-experimental design (see section 3.4) to enable the estimation of the counterfactual effect of the program from the control and treatment group (Baker, 2000; Ferraro and Pattanayak, 2006; Dunning and Hyde, 2008). The treatment group was defined as households who had implemented SLM practices under EPWS program and whose farms had been measured for payment or had already received payments, while the control group was composed of households who had not registered their names with EPWS program. The treatment group comprised 116 household heads and the control group had 117 household heads. These households were selected from a stratified random sample generated through a participatory wealth ranking exercise (see section 3.3.5).

Household surveys were conducted during the second phase of the research process from March to May 2011 in four villages. A mixture of both closed semi-quantitative and open qualitative questions (Downward and Mearman, 2007; Gray, 2009) were used to investigate the determinants of landholders' decision to participate in the EPWS program and livelihood and environmental impacts of the program (types of data collected for each research objective are shown in subsequent chapters). A household was described as people who live and sleep in the same compound, including absentees (Randall et al., 2011). The heads of households were selected for survey using stratified random sampling technique

generated through wealth ranking technique to ensure representativeness (Chambers, 1994; White and Pettit, 2004).

3.3.5 Wealth Ranking

According to Van Campenhout (2010), participatory wealth ranking can be a best way of generating poverty indicators and profiles that incorporate local perspectives on poverty. To perform wealth ranking in this study, Chambers' (1994) steps and advice for maintaining the strength of the wealth ranking exercise sensitive to local circumstances and expertise were followed. In the first step, key informants who had lived longest in the community and who knew most about the livelihoods of households in the area were selected following Mukherjee (1998) and Stocking and Murnaghan (2001). Village and sub-village leaders were selected first and, with their help, two other representatives were selected to form a wealth ranking group of 6 – 8 people.

Lists of names of the household heads from each village were collected from village records in the second step. The lists were verified with key informants to harmonise shared similar names, adding new households and deleting deceased individuals. Through a collaborative effort between the researcher and key informants, a simple fivefold wealth classification approach was adopted based on the five different types of livelihood capital assets (Table 3.1) identified by Carney(1998) and Ellis (2000).

Table 3.1. The five livelihood capital assets used to characterise wealth in the wealth ranking exercise

Type of capital asset	Description
Natural capital	Land, water and biological resources that are utilised by people e.g. forest resources
Physical capital	Assets created by economic production processes e.g. buildings, irrigation canals and roads
Human capital	The labour available to the household including education, skills, and health
Financial capital	Stocks of money to which the household has access e.g. saving and access to credit in the form of loans
Social capital	Community and wider social ties on which households can rely

Source: Ellis (2000: 16)

Based on the key informants' translation of these criteria of poverty or wealth (Mukherjee, 1993; Adams et al. 1997), a number of proxy indicators for each type of capital asset were identified by the key informants enabling the classification of households into three groups according to wealth level- rich, middle and poor.

Wealth ranking derived from participatory methods is a useful tool in deriving poverty indicators and profile poverty or wealth of one particular village (Southgate et al., 2010; Zhang and Pagiola, 2011). However, when it comes to comparing villages, participatory wealth ranking does not allow comparison across villages because criteria used in one village may vary in another village, resulting in non-comparable distributions (Place et al., 2007; Southgate et al., 2010). Due to this limitation, this study used additional wealth grouping method in addition to participatory wealth ranking used to classify households into three groups – rich, middle and poor to facilitate sampling of the household survey. The other method involved calculation of an asset level for each household, based on monetary values. This method provided the basis for the division of the entire

sample into asset quartiles. The total asset value for each household was based on the type and number of assets owned and valued at the average price across the full sample (see section 3.5.10.5).

3.3.6 Sampling

As the level of analysis in this study was the household, a household survey was carried out in the four villages of Kibungo, Nyingwa, Lanzi and Dimilo. However, defining the household as a unit of analysis is challenging due to the complexity and variability of the arrangements that people make to facilitate provision of food and/or other essentials for living. In the study villages and Morogoro Region in general, the household unit is defined in terms of rights to land, with every village household being allocated its own residential plot and farmland by the village government (Lyamuya et al., 1994). New households are formed as adult children move out of their parents house to marry and start their own families, with their own areas of farmland (Lyamuya et al., 1994).

Informed by Baker (2000), participatory wealth ranking was followed by the random sampling exercise to select a representative sample of 233 household heads for interviews from EPWS participating (treatment group) and non-participating (the control group) households in the study villages (see table 3.2). The treatment group was defined as those households who were enrolled in the EPWS program while the control group were those who were not enrolled in the EPWS program but possessing the same characteristics as the former. The sample sizes represented between 16 and 21% of the village households (Table

3.2). Stratified sampling was used to ensure representation of all wealth groups and all sub-villages as well as both gender groups. For each household in the sample, one respondent was interviewed; the person being either the head of the household or a spouse of the head of household. The gender distribution of the total sample is 65.1% male and 34.9% female respondents, which allowed for gender disaggregated analysis. Table 3.2 shows the village study sites and sample sizes, while wealth distribution of household survey sample is presented in Table 3.3.

Table 3.2. Village study sites and sample sizes

Village name	Number of households	Households sampled	Percent of population
1.Dimilo	227	48	21
2.Lanzi	275	55	20
3.Nyingwa	434	70	16
4.Kibungo	279	60	21
Total	1215	233	19

Table 3.3. Wealth distribution of household survey sample

Village		Poor	Middle	Rich	Total
Kibungo	# of observation	19	35	6	60
	%	31.7	58.3	10.0	100.0
Nyingwa	# of observation	18	45	7	70
	%	25.7	64.3	10.0	100.0
Dimilo	# of observation	22	20	6	48
	%	45.8	41.7	12.5	100.0
Lanzi	# of observation	14	29	12	55
	%	25.5	52.7	21.8	100.0
Sample	# of observation	72	129	31	233
	%	31.0	55.6	13.4	100.0

In addition to participatory wealth ranking, the classification based on the total value of assets of the household was performed to generate grouping of households that allowed inter-village comparison. As such, the measurement of

asset values helped to overcome limitations that could be experienced from participatory wealth ranking method (Zhang and Pagiola, 2011). Table 3.4 shows the comparison of the results of the participatory wealth ranking and the asset quartile wealth ranking. Both types of wealth grouping were highly significantly positively correlated (Spearman: $r=0.250$, $p<0.00$; Kendall's tau_b: $r=0.273$, $p<0.00$).

Table 3.4. Comparison PRA wealth grouping and asset quartile groups

		1 (poorest)	2	3	4 (richest)	Total (n)
Wealth group by PRA	Poor	35	15	11	12	72
	Middle	19	34	44	32	129
	High	5	9	3	14	31
Total		59	58	58	58	233

Note: The total asset value (ranges) of the asset quartile groups in TSH are as follows: 1 < 651,000; 2 = 651,001 - 908,000; 3 = 908,001 – 1,412,000; 4 > 1,412,001

3.3.7 Interview Procedure

Using a semi-structured questionnaire, the interviews were administered directly by the research team, without interference from local officials and the use of face to face interview methods ensured a high level of completeness and accuracy of the data. Meetings with the interviewer every day prior and after household visits ensured consistency and the recording of additional notes and observations. The completed questionnaires were field checked in the evenings to minimize errors and missing data items. Most interviews were carried out outside of people's houses, a setting at which respondents would feel familiar and not be inhibited in their responses. The setting furthermore allowed the enumerators to assess the characteristics of housing through personal observation without directly asking and to note down any other personal observations about the living conditions of the particular household.

3.3.8 Semi-structured Key Informant Interviews

During the first and second phases of the research, semi-structured interviews were conducted with 31 people. These included 3 EPWS program staff, 4 village leaders, 8 representatives from EPWS groups in program villages and 8 EPWS participating and 8 non-participating household heads. The purpose of these semi-structured interviews was to investigate the drivers of participation in the EPWS program and livelihood and environmental impacts of the program. The focus was on the explanation and clarification of preliminary analysis of the findings and on missing information that could not be captured in the second phase of the research. Informed by the survey, interviewees were selected to represent a mix of gender and wealth groups. The interviews were conducted in 'Swahili', audio recorded and then transcribed into English.

3.3.9 Focus Group Discussions

Sixteen focus group discussions (FGDs) were conducted in phase three of the research for triangulation purposes and in order to further explain the findings of interest which had arisen from the analysis of the household survey – phase two data (Hopkins, 2007). Following the guidance of Hopkins (2007) and Creswell and Plano Clark (2007) the participants who had substantial experience and knowledge of the topics and who had been identified during the second phase were balanced to cover both women and men, and wealth groups to ensure representativeness. Separate and mixed FGDs were conducted with 8-10 EPWS program participants and non-participants from each program village. The focus group discussions were conducted in 'Swahili', audio recorded and then transcribed in English.

3.3.10 Fieldwork Observations

In all three phases of the research, the overt observation (where everyone knows they are being observed) method was used to investigate cross-cutting issues that were particularly of relevance to the components of this thesis (Taylor-Powell and Steele, 1996; Gray, 2009). Various aspects of the EPWS program intervention, and household livelihoods were observed to allow the validation of responses from household interviews, key informant interviews and focus group discussion and thus contributed significantly to the triangulation process. Photographs and field work notes were taken throughout the research period. Probing questions such as 'how', 'why', 'when', 'how much/how many' were asked in a non-intrusive manner to tease out details on issues of particular research interest.

3.3.11 Field Experience

Permission to conduct research in Kibungo Juu ward was granted by the Ward Executive Office of the Kibungo Juu ward, District Administrative Secretary of Morogoro rural district, and Regional Administrative Secretary of Morogoro region with institutional support from the University of Dar es Salaam. Formal introductory meetings were held in each sub-village on entry with leaders and community members through the facilitation of the Village Executive Office in each village. In these meeting, the role of the researcher was explained in the village and people were told that a research student was conducting research on environmental and livelihood issues and that the purpose of the research was to learn from them about these issues.

Throughout the research, the researcher maintained vigilance of the research process. Temporary research assistants with a degree qualification were employed to assist during the household questionnaire interviews. These research assistants were selected after examining their potential to act objectively within interview and group situations. Prior to implementing the surveys widely and following the pilot in Kibungo village, all field assistants were trained and practiced posing the questionnaires to one another. The researcher rotated among field assistants as they performed interviews to ensure that the assistants asked questions in a consistent manner. Each evening the researcher examined questionnaires to ensure that there were no inconsistencies, and in the event of discrepancies, the interviewee was followed the following day for clarification.

In each village, one local research assistant was hired to direct the research team in the village and sub-villages, and to the respondents' homes. This was important because of their considerable local knowledge and to assist in introducing the interviewers to households, as they might be less intimidating for respondents. The approach to the respondent's house was usually made by the local research assistant. It was explained to the respondent that the interviewer was a visiting researcher, and would like to talk to them, if possible. Interviews were then either conducted inside or outside the home in the absence of the local research assistant. The interviewer started by explaining the purpose of the research and that the researcher was a student studying these sorts of projects and was interested to hear their experience.

Kiswahili is the national language in Tanzania and was spoken at the study sites. As such, there was no language problem because Kiswahili is the common language for the researcher and research assistants as well as the respondents.

Numerous forms of bias can enter into data collection. The researcher's main concern was the identification of the research with CARE/WWF or the government, which could impose biases in the responses. To avoid this, a car was hired and CARE/WWF or government transport was avoided. Also, research assistants/interviewers were asked by the researcher to be as clear as possible to avoid being associated with the project. As such, respondents were helped to understand the purpose of the research in order to gain trust and limit biases. However, some individuals would inevitably look upon the interviews with suspicion. Yet this suspicion cannot be solely attributed to the researcher's relationship with CARE/WWF because suspicion of outsiders is common in the area.

In addition, respondents sometimes asked questions at the end of the interview showing that the distinction between the interviewer and project management was not very clear in their minds. In this scenario, people asked the interviewer to change things about the project. However, the interviewers were trained to reiterate that they were not involved in the project management and, although the findings would be available to CARE/WWF, the researcher could not guarantee anything would change. This was done purposely to ensure the researchers' presence would not raise unrealistic expectations.

In the second phase of the research, people were much more interested in the researcher and the research work and they became more comfortable talking due to the teams' engagement with people in some local activities and as they got to know the research team. For example, the team inspired students at the Kibungo Secondary School by discussing with them the importance of education and how to handle challenges and also worked with the community in making bricks for the local secondary school and in road clearing.

Another concern was about the researchers' relationship with CARE/WWF staff. However, this did not pose any conflict of interest in the researchers' critical evaluation of their intervention. They made clear to the researcher that they wanted the brutal truth and they were open in describing both the successes and failures that they perceived in the intervention. As such, the researcher does not believe that bias was introduced in the analyses and conclusions due to a desire to impress CARE/WWF.

Throughout the research process, strict ethical procedures approved by the University of Leeds were followed. Firstly, to address the risk of disclosure, all data were stored securely and anonymised in presentation. It was particularly important that the researcher never reported to CARE/WWF any information directly linked to any individual and that was emphasised to respondents. The research assistants were also briefed on these ethical codes. For seeking informed consent, the interviewers explained to respondents the purpose of the research and what the researcher would do with the information they gave. After

this, they were given a choice as to whether or not to be involved. Due to literacy issues and sensitivities over using signatures, verbal consent was sought.

Another consideration relates to reward for research participation. The researcher felt the presence of poverty and the fact that people gave up time to participate warranted something more than gratitude. However, this was considered inappropriate because people would want to be interviewed just to receive a gift. After a discussion with the research assistants, the team decided to participate in some local activities such as inspiring students at the Kibungo Secondary School by discussing with them the benefits of education and how to handle challenges and responding to questions asked by students. Also, the team worked with the community in making bricks for the local secondary school and in road clearing.

3.4 Data Analysis

3.4.1 Quantitative Data

Data entry templates were designed and adapted as interviews were carried out. The quantitative data were analysed with Microsoft Excel and IBM SPSS Statistics for Windows for basic, descriptive statistics and R for propensity score matching.

The analysis of the household data reflects the experimental study design by comparing the experimental (EPWS program participants) and the control group (Non-EPWS program participants). A propensity score matching technique which involves the prediction of the probability of the EPWS program participation was performed for chapters five and six (Abadie and Imbens, 2005). The nearest

neighbour matching with replacement variant was performed to match the treatment group with the control group. Out of 117 members of the control group, 67 were matched to 116 members of treatment group. The data set was first disaggregated and compared for the two groups (EPWS program participants and non-EPWS program participants). Subsequently, to investigate the equity question, the data was further disaggregated by the four asset wealth groups and by gender. The gender analysis used sex of the household head (male = 151, female = 81) as grouping variable before matching and (male = 178, female = 54) as grouping variable after matching.

Both parametric and non-parametric tests were used. Parametric tests were performed for household level variables that passed assumptions of parametric test (Kolmogorov-Smirnov test), while non-parametric test was performed for the household level variables that could not satisfy the assumptions of parametric test.

The data gathered through the household survey was, where appropriate, triangulated with results from the qualitative data gathered through personal observation, key informant interviews and focus group discussions.

3.4.2 Qualitative Data

To complement the use of multiple methods, data analysis followed a grounded theory approach (Strauss and Corbin, 1998; Heath and Cowley, 2004). Themes, concepts and ideas based on data collected during the first phase of fieldwork in

Kibungo village (Phase 1) were taken forward during further data collection phases in the same village and in Nyingwa, Lanzi and Dimilo villages (Phase 2 and 3). This approach helped to maintain confidence in research outcomes through the constant comparison across types of evidence (Bailey et al., 1999). Additionally, this iterative process ensured focussed and relevant research development. Data from focus group discussions, key informant interviews and observations were manually coded and grouped on similar themes (Neuendorf, 2002). The themes allowed similarities and differences between data to be easily identified and relevant quotes to be easily extracted. Data were constantly revisited throughout this process and new connections between data were formulated.

3.5 Study site

3.5.1 The Uluguru Mountains - Location

The EPWS program was piloted in Kibungo Juu ward which is located in the Uluguru Mountains of Morogoro region in Tanzania. Morogoro region is located in the Central-Eastern part of Tanzania (URT, 1997). It lies between latitudes 5° 58' and 10' south of the equator and between longitude 35° 25' and 38° 30' east of Greenwich. It shares borders with the Arusha, Tanga, Pwani, Lindi, Ruvuma, Dodoma and Iringa regions. The Uluguru Mountains in the Morogoro region are part of the Eastern Arc Mountain range of East Africa that extends from the Taita Hills in South East Kenya to North and South Pare, East and West Usambara, Nguu, Nguru, Ukaguru, Rubeho (Usagara), Udzungwa and Mahenge Mountains in Tanzania (Burgess et al., 2007). The Uluguru Mountains are about 46km long and rise out of the coastal plain at approximately 300m above sea level to a peak

of 2,638m above sea level around the Lukwangule plateau and 2634 m above sea level a second peak at Kimhandu (Bhatia and Ringia, 1996)(Doggart et al., 2005). These mountains are situated at 07°00' South and 37°40' East (Lovett and Wasser, 1993). The Uluguru Mountains are divided into Uluguru South and Uluguru North by the Bunduki gap which is a saddle between the two main ridges.

The foothills divide the main Uluguru mountain ranges from the lowland plains that reach towards the Mikumi, Selous and the coast (Doggart et al., 2005). These Mountains and their foothills are a mosaic of forest, woodland, cultivation and grassland. In both Uluguru North and South Forest Reserves, forest is most extensive from 1500 m above sea level (Doggart et al., 2005). Below this altitude, submontane and lowland forest exists as fragments in a matrix of agricultural land (Doggart et al., 2005). Woodland is extensive on the drier foothills with *Brachystegia* sp. dominant in the moister areas giving way to *Acacia* sp. woodland in the drier areas (Doggart et al., 2005). Cultivation ranges from maize and cassava at lower altitudes to a mix of vegetables and bananas higher up. The Lukwangule Plateau has the most extensive natural grasslands and is dominated by the endemic grass *Panicum lukwangulense* (Doggart et al., 2005). Other areas of grassland exist in the lowlands; formerly these areas may have been under cultivation and before that forest or woodland (Doggart et al., 2005).

3.5.2 The Climate of the Region

The climate of Morogoro region and the Mountains is very much influenced by the Indian Ocean. In general, the rainfall in the Mountains ranges from 2,000-4,000 mm per year. The eastern highlands, western highlands and the lowlands that are adjacent to the mountains receive rainfall that varies between 890 mm and 2,392 mm per annum (Lovett and Po'cs, 1993; Lovett and Fjeldsa, 1995; Lovett, 1996). Temperature also changes with altitude, ranging from below 0°C to 26°C at the higher and lower altitudes, respectively. In Morogoro town, the average air temperature is 24°C with the coolest month being July (21°C) and the warmest being December at 26°C (Masawe, 1992).

Between 1997 and 2008, the region experienced both the highest and two lowest rainfall years on historical record (Paavola, 2008). In normal years, the Morogoro region has the bimodal and unimodal rainfall patterns of northern Tanzania (Paavola, 2008). The *Vuli* are the short rains in the north of the region and they start between mid-September and mid-October and continue until December, while the long *Masika* rains start in March and last until May (Paavola, 2008). The *Msimu* rains in the southern part of the region start in November and end in April or May (Paavola, 2008).

The region has also experienced declining rainfall trend (Paavola, 2008). Since the 1950s, evaporation in the Uluguru mountains has increased four-fold, impacting the flow rate of the rivers whose headwaters are from the mountains (Paavola, 2008). Records taken in Mgeta sub-catchment showed that the dry season and rainy season flows declined by $0.2 \text{ m}^3 \text{ s}^{-1}$ while annual flows declined

by $0.1 \text{ m}^3 \text{ s}^{-1}$ over 35 years period. In Kibungo sub-catchment, the dry season flows declined by $5 \text{ m}^3 \text{ s}^{-1}$ (annual rate of $0.1 \text{ m}^3 \text{ s}^{-1} \text{ yr}^{-1}$) in the last 35 years while annual rainy season flows declined by $9 \text{ m}^3 \text{ s}^{-1}$ and $16 \text{ m}^3 \text{ s}^{-1}$ over the same period (Yanda and Munishi, 2007).

3.5.3 Biodiversity

High biodiversity richness (species richness, diversity and endemism) is one of the strong features of Uluguru Mountains forests (Myers et al., 2000). According to the survey conducted by Doggart et al. (2005), more than 381 plant species were recorded in the Mountain forests and their foothills. Also, more than 300 vertebrate species were recorded in the Mountains forests and their foothills (Doggart et al., 2005). Of these, birds were the most diverse order with 140 species and amphibians the least diverse with 39 species (Doggart et al., 2005). Despite the richness of species in the Ulugurus, people who use resources from the forests have reported declining trend and disappearance of some tree and animal species (Hess et al., 2008).

Surveys on the endemism of the species have shown that the Uluguru Mountain forests contain at least 135 endemic plant taxa plus hundreds of species shared only with other Eastern Arc Mountains (Burgess et al. 2002). Also, a survey conducted by Doggart et al. (2005) recorded 16 endemic and 54 near-endemic vertebrates in the Ulugurus. They also reported that Amphibians have the highest number of endemic and near-endemic species (24) and bird is the lowest species (12) (Doggart et al., 2005). In another survey, the share of endemic species for

birds included; six globally threatened birds including the Uluguru Bush Shrike, two globally near- threatened birds including Love Ridge' Sunbird and six other forest birds of extremely restricted range (Bhatia and Ringia, 1996). Two shrew species and three mammal species were included in the 1994 IUCN Red list of threatened animals (Lyamuya *et al.*, 1994).

3.5.4 The Importance of the Uluguru Mountains for Water

The watershed resources of the Uluguru Mountains are important for the livelihoods of the people in the mountains and in the downstream. The mountains harbour watersheds that are the main source of water for two of Tanzania's major cities (Hymas, 2001). The Ngerengere and Morogoro Rivers, whose headwaters are in Uluguru North, provide water for the regional capital, Morogoro before flowing into the Ruvu River (Brouwere *et al.*, 1998; Myers *et al.*, 2000; Yanda and Munishi, 2007). The Ruvu River, which drains Uluguru North and South, supplies water to Dar es Salaam; the largest and most industrialized city in Tanzania with a population of approximately 4.3 million people (URT, 2012). The mountains through these rivers supply more than 85% of water for domestic consumption and about 80% of the water needed by industries in Dar es Salaam (Lopa and Mwanyoka, 2010; Branca *et al.*, 2011).

The flows and quality of water from the Uluguru Mountains are of significant concern to downstream water users. Hydrological analysis conducted between 1992-2003 in the Ruvu river revealed considerable decline in water quantity and quality (Yanda and Munishi, 2007). Decreasing trends of flows have been

recorded during the dry season and increasing trends during the rainy seasons (Yanda and Munishi, 2007). These trends are indicators of low water storage capacity in the catchments and increased surface run off resulting mainly from vegetation degradation.

The major concern in water quality from the Uluguru watersheds is decreased cleanliness as a result of increased turbidity or sediment loading. Analysis of mean monthly turbidity in the Ruvu River between January 1992 and November 2002 showed that the water turbidity levels in the Ruvu River increased from 130 Nephelometric Turbidity Units (NTU) in 1992 to 185 NTU in 2002 (Yanda and Munishi, 2007). This increase in turbidity is about 5 NTU per year reflecting an increase in sediment loading in the river over the same period. This trend of increasing turbidity has been reported as a consequence of forest encroachment for agriculture and general vegetation degradation resulting from erosion and higher sediment delivery into streams. Projections suggested an annual increase in turbidity levels of 1.5 NTU and 3% over the 20 years post 2002 (Yanda and Munishi, 2007). The increase in the turbidity levels in the Ruvu River is identified as the reason for the increase in costs for water purification by the Dar es Salaam Water Supply Company (DAWASCO) and increase in water shortage in Dar es Salaam City (Lopa and Mwanyoka, 2010). Estimates showed that DAWASCO spends about US\$ 2 million on water treatment annually (Branca et al., 2011). These costs are expected to increase with expected increase in turbidity episodes under a business as usual situation (Lopa and Mwanyoka, 2010).

3.5.5 The Status of the Forests in the Uluguru Mountains

The status of the forests, woodlands and bush lands in the Uluguru Mountains and the Ruvu Basin are a key determinant of downstream water quality and quantity (Pócs, 1976; Svendsen et al., 1995; Burgess et al., 2001b; Burgess et al., 2002; Yanda and Munishi, 2007). However, the land cover analyses for the basin from 1955 to 2000 have shown considerable increase in cultivated land and decline of bush lands, woodlands and forests (see Table 3.5) (Yanda and Munishi, 2007). The original forest cover in the Uluguru Mountains was estimated to be 500km². However, it declined to around 300 km² in 1955 and to 230 km² in 2001 (see Figure 3.2) (Burgess et al., 2001a; Burgess et al., 2002). The remaining forest is exclusively on reserved land gazetted as either national or local authority Forest Reserves and small forest patches on village lands (Doggart et al., 2005). However, even in these areas, threat of forest decline is considered considerable.

Table 3.5. Land use/cover for Ruvu Basin (1995 – 2000)

Land use/cover types	1995		2000	
	Area (h)	%	Area (ha)	%
Bush land	293,764	24	217,700	18
Cultivated Land	87,369	7	173,468	14
Grassland	302,458	25	493,116	41
Natural forest	32,402	3	3,833	0
Permanent swamp	1,334	0	1,071	0
Urban	1,401	0	961	0
Water	833	0	912	0
Woodland	495,526	41	321,388	26
Total	1,215,087	100	1,215,087	100

Source: Yanda and Munishi (2007)

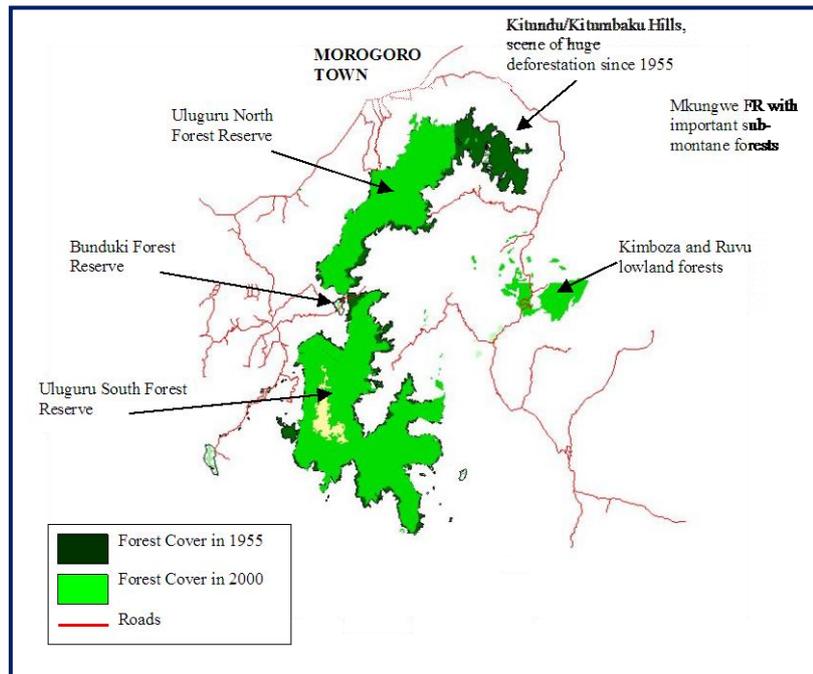


Figure 3.2. The Forest Cover Change between 1955 and 2000
Source: Burgess *et al.* (2001a)

Historically, the Uluguru Mountains forests, woodlands and bush lands have been threatened by the expansion of agricultural land and the economic and demographic pressures that have driven that expansion (Doggart *et al.*, 2005). With respect to demographic pressures, the population in Morogoro region increased from 1,753,362 inhabitants in 2002 (URT, 2006) to 2,218,492 inhabitants (URT, 2012). It is also estimated that about 150,000 people live in 51 villages bordering the forest reserved areas of the Uluguru Mountains (CARE and WWF, 2008). These people depend on the Mountain forest resources for resources such as fuel wood and medicinal plants, wild foods and supply of materials for building and weaving (Lovett and Po'cs, 1993; Burgess *et al.*, 1998; Myers *et al.*, 2000; Hall *et al.*, 2009).

Encroachment and extension of agricultural lands into the forests for new farmland, unmanaged forest fires and logging for timber, charcoal making, building materials and fuel wood collections are reported as significant threats for the decline and degradation of habitats and forest area (Svendsen et al., 1995; Hymas, 2001; Doggart et al., 2005; Yanda and Munishi, 2007). As land fertility in the lowlands is exhausted, people encroach into the forest areas for fertile land. It has been reported that in 1955, thickets covered most of the Ruvu basin area with a few areas in the northern part of the Uluguru Mountains under mixed cropping (Yanda and Munishi, 2007). However, from 1995, more natural vegetation cover was converted into sisal estates and mixed crop farmlands leading to increased exposure of the land surface to erosion agents and increased surface runoff (Yanda and Munishi, 2007).

People collect a variety of products/resources from the forest reserves with different impact on the forests (Hymas, 2001; Doggart et al., 2005). While in remote areas people collect forest products such as fire wood, food and building materials for domestic use, in areas with easy access, they collect forest products for both domestic use and commercial purposes (Doggart et al., 2005). It is in these areas that commercial fuel wood extraction and timber harvesting and encroachment by farmers are more frequently found. Hymas (2001) and Doggart et al. (2005) report that pole cutting was occurring in all forest reserves of the Uluguru mountains for construction of houses. They also reported that hunting was taking place in all forest reserves of Ulugurus. People hunt mammals such as *Cephalophus harveyi* (Harvey's red duiker), *Cephalophus monticola* (blue duiker) and *Potamochoerus larvatus* (bush pig), and birds for

bush meat for local consumption and subsistence. Hunting of some reptile species and animal species such as *Panthera pardus* (leopard), *Colobus angolensis* (Angola pied colobus) and *Cercopithecus mitis* (blue monkey) for skins which the hunters sell to Europeans in Arusha was also reported (Doggart et al., 2005). In addition, live collections of birds such as red-faced *crimsonwing*, *yellow-fronted serin*, *Peter's twinspot*, *African citril*, *oriole finch*, brown snake eagle and *Livingstone's turaco*, chameleons and tortoises were carried out for zoo and pet trade in Dar es Salaam (Doggart et al., 2005).

Fire has been reported as one of the greatest threats to the forests of the Uluguru Mountains (Doggart et al., 2005). Doggart et al. (2005) reported that in all of the forest reserves, clear signs of fire damaging the forest habitats were evident and were spreading from agricultural lands and woodlands. Also, they report that hunters use fire to smoke the hyrax from their trees.

Logging has been reported as a prevalent phenomenon in forest areas with easy access, particularly in low land forest reserves (Hymas, 2001; Doggart et al., 2005). In these areas, more pit sawing was observed. Targeted species included *Khaya anthotheca*, *Albizia gummifera* and *Milicia excels* (Doggart et al., 2005). In some areas, village elders employed villagers to cut wood and in others forest guards were unable or unwilling to tackle the problem of illegal pit sawing observed in the forest reserves (Hymas, 2001; Doggart et al., 2005).

3.5.6 Agricultural Practices in the Uluguru Mountains

The main source of livelihoods in the Uluguru Mountains is rain-fed crop farming, followed by off-farm income, tree/forest resources, livestock keeping and remittances (CARE and WWF, 2007b; CARE and WWF, 2008). Also, small stocks such as chickens, goats, pig and rabbit rearing are considered important assets for generating income and providing food security (Hartley and Kaare, 2001). Some of these stocks such as pigs and goats have the advantage of providing manure for growing vegetables.

Although agriculture is an important source of livelihoods in the Uluguru Mountains, it has been described as unsustainable; and characterised by limited capacity to invest in new technologies, inadequate access to credits and limited extension services (Yanda and Munishi, 2007; Branca et al., 2011). Most of the farming practices are characterized by slash and burn agriculture with very limited use of soil conservation measures (Burgess et al., 2002; Yanda and Munishi, 2007). Also, some areas are characterised by intensive cultivation and encroachment and extension of agricultural lands into marginal lands such as hilly and steep slopes which extend to river banks with little or no conservation measures (Yanda and Munishi, 2007). For example, some parts of Mgeta sub-catchment, the main Ruvu sub catchment above Kibungo and the upper parts of the Ngerengere sub catchment have been degraded due to such agricultural practices (Yanda and Munishi, 2007).

Another feature of agricultural practices in the Uluguru Mountains is increased land fragmentation and decreased time of land fallowing. Most households own

less than two hectares of land and practice semi-intensive subsistence farming using slash-and-burn agricultural technique (CARE and WWF, 2007a). It has been shown that the average total size of household's fields range between 0.25 to 4 acres for minimum; and 2 to 10 acres for maximum (Hymas, 2001). On average, households have between 2.9 and 4.6 fields which are frequently distributed across the landscape (Bhatia and Ringia, 1996). In some villages, people walk an average of 40 minutes to get to their nearest farms and an average of 131 minutes to walk to their furthest farms (Hymas, 2001). Land fallowing in some villages of the Uluguru Mountains has been documented (CARE and WWF, 2007b). Some 18.92% of households in Nyingwa village, 34.04% in Lanzi village, 30% in Dimilo village, and 8.33% in Kibungo village had part of their land left in fallow (CARE and WWF, 2007b).

Crops grown in the Uluguru mountains are maize, rice, cassava, banana and pineapple in fragmented fields (CARE and WWF, 2008). Maize and cassava are the main food crops and banana is the main cash crop grown in many villages of the Uluguru Mountains (Bhatia and Ringia, 1996; Hymas, 2001). Crops such as maize and cassava are food crops with dual purpose of being both for subsistence and cash, with the excess being sold (Hymas, 2001). However, the lack of markets and accessible roads limit diversification of cash crops. Intercropping is practiced by the majority of the farmers in all areas of the Uluguru Mountains and include a variety of crops such as maize and rice, maize and cassava, maize and beans, cassava and pigeon peas (Bhatia and Ringia, 1996; Hymas, 2001). Generally, intercropping is done between fruit trees and annual crops and between cereals/tube crops and legumes (Hymas, 2001).

Crop yields in some areas of the Uluguru Mountains are not as they used to be in the past. In the study conducted by Hymas (2001), farmers commented that their best yields were obtained in the 10 to 40 years prior to the study. Average yields had declined significantly as people were getting 1 to 12 bags compared to 7 to 30 bags they used to get in the past (Hymas, 2001). Farmers relate poor yields to soil erosion, poor agricultural practices, change in climate resulting in more risky farming especially in the short rains, decreased soil fertility and decreased rainfall (Lyamuya et al., 1994; Hymas, 2001).

Poor road infrastructure limits access to many of the remote villages in the Uluguru Mountains and services such as agricultural extension services and markets. Many villages do not have a main market or accessible roads that are in good conditions (Bhatia and Ringia, 1996). Villages with difficult access, especially inaccessible roads, lack agricultural and forestry extension services (Hymas, 2001). The absence of extension services limits possibilities farmers might otherwise have to improve agricultural production and forest management. Also, poor roads limit the access to markets and hence the cash crops that can be grown (Bhatia and Ringia, 1996).

The income of the majority of the households in the Uluguru Mountains is very low. As measured in the 2000/01 Household Budget Survey, the mean rural monthly household income in the rural areas of the Morogoro region is almost three times less than the mean urban monthly income (i.e. 37,400 Tsh per month

(which equals about \$ 1 per day)³. People spend about two thirds of their income on food and a third of households suffer from basic needs poverty and 14 percent of households are below the food poverty line (NBST, 2002a: 180). To supplement their income, young boys and girls in some households work (Hartley and Kaare, 2001). In a village like Lanzi, young boys aged between nine and fifteen years get employment as porters (carrying banana and timber) (Hartley and Kaare, 2001). Also, in other villages like Lukuyu, young girls and boys take up waged employment as domestic servants in Morogoro town and other neighbouring regions (Hartley and Kaare, 2001).

3.5.7 Land Access and Tenure

In the Uluguru Mountains, land is the major household's asset used to grow food and cash crops as the main source of livelihoods security (Hartley and Kaare, 2001). As an asset, some households rent out their land to supplement their food requirements through receiving 'Ngoto' (a proportion of harvest paid to the landowner) from the tenant (Hartley and Kaare, 2001). Also, some households and individuals in some villages such as Ng'ungulu and Lukuyu sell their land to an emerging land market comprising young men (Hartley and Kaare, 2001). In addition to accessing land through renting and purchase, land can also be accessed through inheritance through the matrilineal or patrilineal system (Englert, 2008). Most of the land involved in selling and patrilineal inheritance, had been declared village land under the villagisation program in 1975 (Hartley and Kaare, 2001).

³ In 2011, 1\$ was 1457 TSH (Tanzanian Shillings)

Given the types of land access, the main forms of land tenure in the Uluguru Mountains are the village government and customary land user rights (CARE and WWF, 2007b; Englert, 2008; Lopa et al., 2012). Of these, the dominant system is the village government land user right stated in the 1999 Village Land Act as a derivative right on use and occupancy (CARE and WWF, 2007b; Englert, 2008). Also, the Act recognizes customary land user right for land allocated to a villager or owned by a clan (CARE and WWF, 2007b). Clan lands owned under customary user rights are accessed through inheritance (CARE and WWF, 2007b).

According to Young and Fosbrooke (1960), clan land in the Uluguru mountains was structured/acquired through matrilineal descent in terms of lineage. In this system, lineage is traced from the original settler of an area and through which, identity for a right to live on and work a land was established (Young and Fosbrooke, 1960; Van Donge, 1993b). Traditionally, land under matrilineal systems was inherited through the sister's son and the first sister's first son in particular; though this is not a rule and succession may go to no particular son (Young and Fosbrooke, 1960; Englert, 2008). In this system, land itself is held by the matrilineal clan. However, while this system of clan land ownership was still very active in the late 1980's (Van Donge, 1993b), the situation has grown more complex with the traditional system slowly being eroded due to demographic, economic and outside pressures (Hymas, 2001; Englert, 2008).

Individualization of land has increased and land inheritance through the father or through either parent has become more common (Van Donge, 1993b; Van

Donge, 1993a; Lyamuya et al., 1994; Hymas, 2001; Englert, 2008). According to Hartley and Kaare (2001) and Englert (2008), the factors that appear to be pushing Waluguru inheritance patterns towards inheritance through the father's line include (1) 'the role of the village government in allocating land in post-colonial Tanzania following *Ujamaa*'; (2) Islamic religious influence; (3) the extent to which a settlement has become cosmopolitan and is influenced by commercial factors; (4) and the extent to which individuals use the courts, which have tended to be arbitrary in their rulings to settle land disputes'. Nevertheless, paternal inheritance is not a new phenomenon because in times of need it was always possible to inherit land from the father (Young and Fosbrooke, 1960), thus the occurrence of inheritance can be either paternal or maternal (Hartley and Kaare, 2001; Hymas, 2001; Englert, 2008).

Another important aspect of land is the power of decisions over the use of a land (i.e. where and what to plant in any piece of household land) which is influenced by who controls the land (Hartley and Kaare, 2001; Englert, 2008). For example, women are given the upper hand in decision making over a land inherited under the matrilineal kinship system (Hartley and Kaare, 2001). Therefore, women have considerable economic independence and the ability to use land resources both in terms of cash crop farming and off-farm activities. However, this gender inequality is mainly attributable to the villages and clans adhering to their traditional matrilineal kinship.

3.5.8 Conservation Practices in the Uluguru Mountains

Many conservation initiatives have been used in the Uluguru Mountains watersheds. These can be traced back to around 1909 when about 277 km² of the Uluguru South and Uluguru North mountain forests were declared forest reserves by the then German colonial government (Doggart et al., 2005; Schreckenbergr and Luttrell, 2010). Later in the 1940s protection was enhanced by the British colonial administration (Temple, 1972; Bhatia and Buckley, 1998). During German occupation, conservation approach used involved expelling land users who were practicing shifting cultivation, without any relocation assistance (Young and Fosbrooke, 1960; Temple, 1972; Lyamuya et al., 1994; Frontier-Tanzania, 2005). In addition to the creation of protected areas, other approaches included tree planting in 1921 so as to prevent erosion and for fuel wood harvesting, laying grasses and weeds to reduce sheet wash, and 1929 Native Authority regulations to control the burning of grass or bush on land other than the owner's without permission (Temple, 1972). Other approaches were the 1930s' planting of more permanent crops such as coffee to reduce sheet wash, use of trash contour ridges, reforestation and improvement in the protection of residual forest areas (Temple, 1972).

Between 1936 and 1937, trial plots and experimental ladder or step terraces for vegetables and potato growing were established by the German colonial government (Temple, 1972). Also, between 1937 and 1943, major conservation works were oriented toward education and establishment of demonstration sites for soil management (Temple, 1972; Lyamuya et al., 1994). Between 1955 and 1980 during independence, conservation activities had more or less ceased and,

within this period, pressure on the forests increased with timber being taken from the more accessible areas of the forest and agricultural lands being created by cutting trees that had been planted as well as previously untouched forest (Temple, 1972; Lyamuya et al., 1994).

After independence, Tanzanian government inherited the command and control approach used during the colonial period for the conservation of Forest Reserves in the Uluguru Mountains (Lyamuya et al., 1994). This approach excluded people from accessing resources from protected areas and when caught in the forest reserves, they were punished (Lyamuya et al., 1994). However, this approach has been considered difficult to maintain because of high pressure on forest reserves associated with population growth and limited government capacity to finance the necessary controls (Hutton et al 2005). As such, several other conservation interventions have been introduced to manage forest reserves and farmlands in the Ulugurus.

One of these interventions is the 1990's range of experiments implemented by assigning specific forest management roles to communities in and around the Uluguru Mountains. Such initiatives have become to be known as participatory forest management (PFM) approaches (Blomley and Ramadhani, 2005; Blomley et al., 2008). These interventions were enhanced by the changes made to the 1957 protectionist Forest Ordinance by the creation of 1998 Forest Policy, National Environmental Policy (1997), Environmental Management Act No. 20 of 2004 (Vyamana, 2010) and Village Land Act 1999. These changes have encouraged the involvement of local communities in forest management

through Community Based Forest Management (CBFM) and Joint Forest Management (JFM) (Vyamana, 2010).

Along with forest conservation, other conservation interventions in the Uluguru Mountains have been focused on farmlands to improve land use practices and increase agricultural produce. These include interventions such as awareness creation on sustainable agriculture/conservation agriculture, establishment of community nurseries, training of trainers, support on livestock and crop production, training on the make and use of manure, traditional pesticides, beekeeping and agro forestry practices. These interventions have been implemented by both Tanzanian government institutions and Non-Governmental Organizations (NGOs). Government institutions include Morogoro Municipal Council, Morogoro Rural District council and Mvomero District Council, Regional Catchment Forest Office (Forest and Beekeeping Division), and Sokoine University of Agriculture. NGOs are like the Wildlife Conservation Society of Tanzania (WCST), CARE, MVIWATA, Uluguru Mountains Agriculture Development Project (UMADEP) and WWF.

For example, the Uluguru Mountain's Environmental Management and Conservation Project (UMEMCP) was an integrated conservation and development (ICD) program aimed to enhance forest management and deliver livelihood benefits through improved agriculture, agro forestry, small enterprise and marketing (Phiill et al., 2005). Another project was the UMADEP focused in the Mgeta and Mkuyuni areas of the Ulugurus and operated by the Sokoine University of Agriculture (SUA), Morogoro (Hartley and Kaare, 2001). This project

supported activities such as saving and credit groups, improvements in livestock keeping, assistance to women's groups and improvement of the mountain agriculture.

3.5.9 The EPWS Program

The Equitable Payment for Water Services (EPWS) program was an agro-ecosystem based PES program conceived as an innovative market-based solution to environmental problems in the Uluguru Mountains. The overall goal of the EPWS program was to deliver sustainable natural resource management (modifying land use to conserve and improve “watersheds” for reliable flow and quality of water) and improved livelihoods of the rural poor with social justice and equity (Lopa and Mwanyoka, 2010). One of the objectives of the program was to establish long term financial investment for modifying land use practices to conserve and improve “watersheds” for reliable flow and quality of water. The second objective was to establish a compensation mechanism that recognizes the needs and priorities of marginalized and poor people to improve their quality of life, hence contributing to poverty reduction (Lopa and Mwanyoka, 2010).

The third objective of EPWS program was to work with the upstream and downstream stakeholders to create a win-win scenario where both the upland communities (i.e. the stewards of the catchment) and downstream water users benefit. The fourth objective was to ensure that program resources are used according to the priorities and needs of the poor, local values and knowledge and practices are incorporated in the natural resource management practices and that woman and marginalized groups directly participate and benefit. The fifth

objective was to engage a wide range of national partners in implementation, including local NGOs, the private sector and government agencies and institutions (Lopa and Mwanyoka, 2010).

The EPWS program was implemented between 2006 and 2012 in the Kibungo sub-catchment, within Kibungo Juu Ward (Figure 3.3) located about 85km South-East of Morogoro town. This sub-catchment is one of the three highly degraded sub catchments of the Ruvu basin (Yanda and Munishi, 2007). The Kibungo sub catchment drains a bigger part of the basin and contributes more flow into the basin (Yanda and Munishi, 2007). However, this basin is relatively more degraded due to unsustainable agricultural practices characterised by shifting cultivation, slash and burn agriculture, cultivation of non-cover annual crops and encroachment into steep slopes and river banks (Lyamuya et al., 1994; Yanda and Munishi, 2007). These practices degrade downstream water flow because of limited conservation measures in the basin. Also, due to land scarcity, the area is characterised by extensive land fragmentation which involves ownership of more than one small piece of land in different locations (Lyamuya et al., 1994; Yanda and Munishi, 2007).

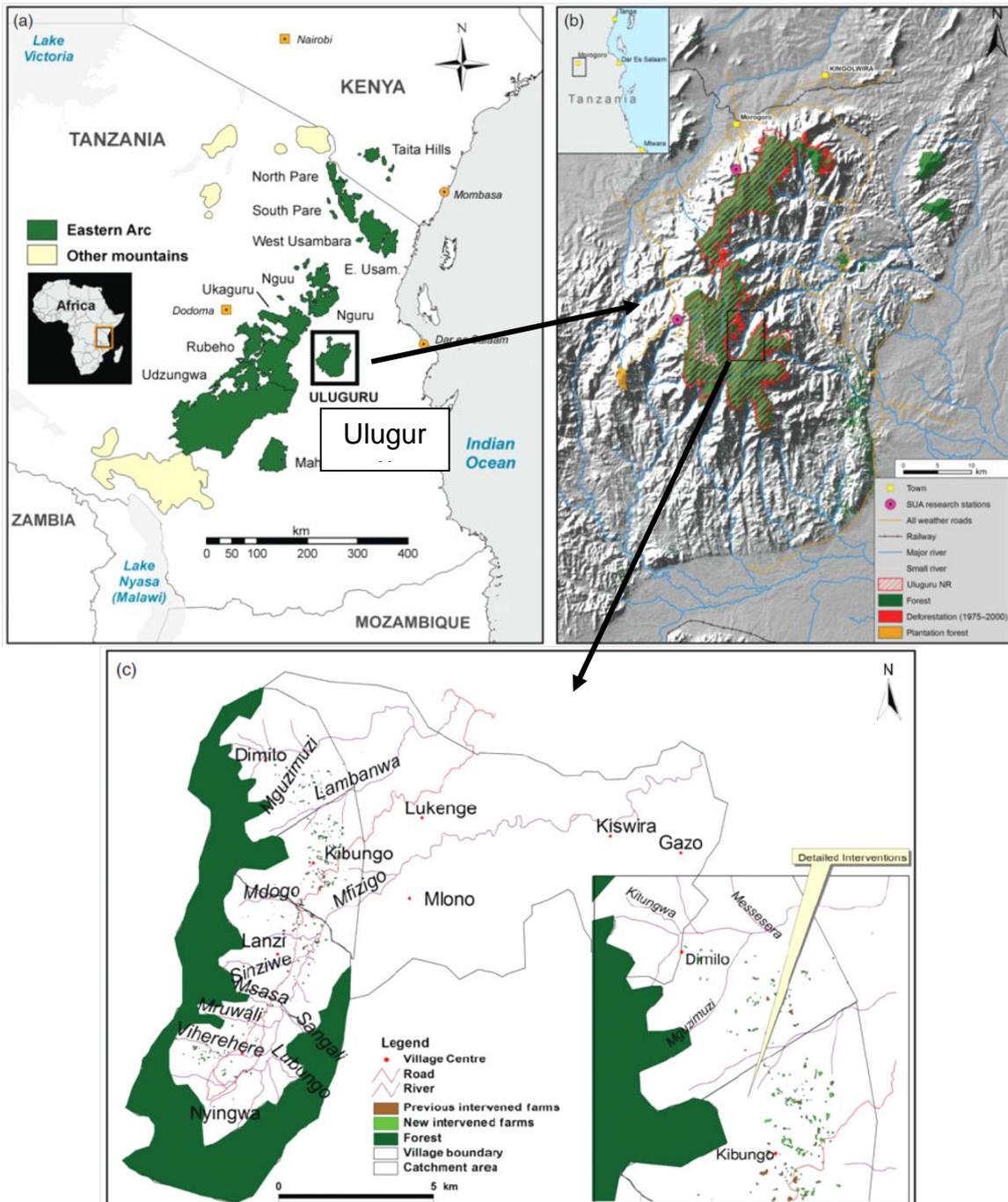


Figure 3.3. (a) The Eastern Arc Mountain (b) The Uluguru Mountains showing the location of the EPWS program. (c) Kibungu sub-catchment in the Uluguru Mountains, showing the location of villages and small streams and the location of the focal villages and individual farmers' fields under project interventions (inset). Source: adopted from Lopa et al.(2012)

Prior to the EPWS program, some farmers had implemented conservation practices as a result of the Uluguru Mountains' great history of soil and water

conservation practices since colonial rule (Young and Fosbrooke, 1960). They implemented conventional and traditional soil and water conservation measures such as terraces (*terasi za Bw. Kilaka*), stone bunds in areas with abundant stones, vertiver grasses which provide materials for thatching and soil erosion control, contour bunds by planting pine apples and trash lines (use of sticks and dry grasses). Other practices included planting of *Minyaweza* (*Albizia spp.*) trees, planting of sugarcane along riverbanks, land fallowing (3-4 years-*Lugonela*) and the use of bamboo & *Mikangazi* trees (*Khaya spp.*) (CARE and WWF, 2007b; Nsenga, 2008). Also, farmers in Kibungo ward practised mixed cropping in the same field by growing crops such as maize, paddy rice, trees, and cassava in order to diversify the risk of crop failures (Figure 3.4) (CARE and WWF, 2007b).



Figure 3.4. A farm with a number of SLM conservation practices

3.5.9.1 Implementation of the EPWS Program

The buyers of the water services generated through the EPWS program were the Dar es Salaam Water and Sewage Company (DAWASCO) and Coca Cola Kwanza Ltd while the service providers were the upstream farmers of the Kibungo Juu ward villages namely Lukenge, Kibungo, Lanzi, Dimilo and Nyingwa

(Table 3.6) (CARE and WWF, 2007b; Lopa et al., 2012). In these villages, 1,215 households were expected to participate in the program and change their agricultural practices to implement SLM practices on over 2,240 ha of farmland (Branca et al., 2011).

Table 3.6. Demography of the Villages Implementing EPWS in Kibungo Juu Ward, Morogoro Rural District

Village name	Male	Female	Total number of individuals	Number of households
1.Dimilo	428	481	909	227
2.Lanzi	512	589	1101	275
3.Nyingwa	781	953	1734	434
4.Kibungo	515	601	1116	279
Total	2236	2624	4860	1215

Source: (CARE and WWF, 2007b)

These villages cover an area of 35,804 ha of which nearly half falls within the land used by the villages and the rest in reserved forest land under village governance (CARE and WWF, 2007b; CARE/WWF, 2007). Land tenure system is dual, which includes village government and the customary land user rights (CARE and WWF, 2007b; CARE/WWF, 2007; Lopa et al., 2012). The dominant system is the village government land user right (CARE and WWF, 2007b). Land under customary user rights is accessed by clan members through inheritance and by non-clan members through renting or sale. Access to land by women is through their husbands (CARE and WWF, 2007b). However, in case a husband is deceased, women with no children tend to go back to their parents, while those with children continue to use a deceased husband's land to take care of their children (CARE and WWF, 2007b). On average, households in Kibungo ward have 2.2 plots of land (St. Dev. 0.8) which averages 2.9 acres (St. Dev. 1.6) (Table 3.7). Most of the land is used as cropland with only few forest lands (Table

3.7). The majority of these are mixed croplands (Table 3.7). It has also been reported that when first acquired, 11% of the plots in the ward were forestland, 76% were inherited and 15% were purchased. However, these numbers differ from village to village. For example, the share of forest converted land in Nyingwa is quite larger (21%) than other villages (CARE and WWF, 2007b). Of those who inherited the land, 39% held a customary right on the land and 53% have no title (Table 3.3) (CARE and WWF, 2007b). Table 3.7 indicates the land tenure system, ownership and access in the study area.

Table 3.7. Land tenure system, ownership and access for the study villages

		Nyingwa	Lanzi	Dimilo	Kibungo
Average land holding (acres)		2.8	3.1	2.8	-
Kind of Land (%)	Crop land	97.3	97.02	98	97.96
	Forest	2.7	2.08	2	2.04
Legal Title Ownership (%)	Sales	2.7	14.5	20	144.29
	Customary rights	45.95	66.67	42	26.53
	Village ownership	2.7	10.42	4	0
	None	48.65	8.33	38	59.18

Source: CARE and WWF (2007b)

CARE international and WWF Tanzania implemented the EPWS program as program intermediaries between service providers (the farmers in the villages of Lukege, Kibungo, Lanzi, Dimilo and Nyingwa) and service buyers (DAWASCO and Coca Cola Kwanza Ltd) (Lopa and Mwanyoka, 2010; Lopa and Jindal, 2011). As intermediaries, these organisations facilitated the establishment of a business case approach for the program to assist negotiations between service providers and buyers (WWF, 2006). In establishing a business case, several studies were conducted between 2005 and 2007. These included (1) legal and policy

assessment for PES in Tanzania (CARE and WWF, 2007a), (2) social and livelihoods assessment of villages surrounding the Uluguru mountains (CARE and WWF, 2008) and (3) hydrologic and land use/cover change analysis for the Ruvu river (Uluguru) watersheds (Yanda and Munishi, 2007). Also, during this phase, the intermediaries facilitated several educational programs for farmers in the Kibungo Juu ward on the concept of PES and its benefits to the environment and their livelihoods, through village meetings and workshops.

After establishment of the business case, a memorandum of understanding (MoU) between the service providers and service buyers was signed in 2008. The MoU stipulated roles and obligations of all parties. The service providers were to ensure the implementation of SLM practices and, in return, the service users were to provide payments to the service providers for the implementation of the service producing SLM practices. Service buyers, DAWASCO and Coca Cola Kwanza Ltd committed to pay US\$ 100,000 and US\$ 200,000 respectively to the service providers over four years. The implementation of EPWS started in 2008 with internal and external training including local workshops, study tours, extension services and provision of farm materials, manure and seeds (Lopa and Mwanyoka, 2010).

The sustainable land management practices implemented under the EPWS program included agro-forestry, reforestation, bench terraces, grass strips, *fanya juu*, and riparian restoration. The selection of conservation practices was based on the nature of the areas' terrain (slope gradient) determined in percentages. The landscape terrain was categorized into three slope gradient classes, namely

low risk slope gradient (0-15%), medium risk slope gradient (from 15-35 %) and high risk slope gradient (above 35%). Bench terraces and *fanya juu* and *fanya chini* terraces were constructed on 35 % and above steep slopes (TerrAfrica, 2007). Bench terraces were developed on steep slopes after the construction of cross-slope barriers whereby erosion (water and tillage) progressively caused beds to level (Figure 3.5). A bench terrace is defined by a flat or slightly backward or forward-sloping bed. The design of the benches is usually calculated by a formula that relates their size and spacing to the slope.



Figure 3.5. The construction of bench terraces in progress as found in Kibungo village. The left plate shows farmers taking measurements and the right plate shows the constructed bench terraces.

Fanya juu ('do upwards' in Kiswahili) terraces were made by digging ditches and trenches along the contour and throwing the soil uphill to form an embankment (Figure 3.6). A small ledge or 'beam' is left between the ditch and the bund to prevent soil from sliding back. They are constructed to harvest and conserve rainfall and sometimes are laterally graded to safely discharge excess runoff. The embankments (risers) are stabilised with fodder grasses. After some time, *Fanya juu* terraces develop into bench terraces.



Figure 3.6. *Fanya juu* terraces in Lanzi

Fanya chini terraces ('do downwards' in English) are constructed by piling soil or throwing excavated soil below a contour trench to conserve soil and divert water (Figure 3.7). *Fanya chini* involves less labour than *Fanya juu*, but do not lead to the formation of a bench terrace as quickly as *fanya juu* does. In both *fanya juu* and *fanya chini*, grass bands or strips are applied on the slope gradients. *Fanya chini* terraces are implemented on fields with slopes of between 15-35%, which are mostly used for settlement accompanied by home gardens and paddy fields. Grass bands are used with fodder grasses such as *Miscanthus sinensis* (elephant grasses), *tripsacum andersonii* (Guatemala) and *pennisetum purpureum* (napier grass), which provide pasture for goats kept by farmers. Vertiver grasses are used for thatch roofing and handcrafts. In areas where grass strips are used, different grass species are planted in strips along the contour lines. The strips are spaced at suitable intervals to decrease surface runoff velocity and to retain eroded sediments. Grass strips are established on gentle slopes of less than 15%. Besides reducing soil erosion, grass strips provide

fodder for livestock and improve fertility when appropriate grass species are planted.



Figure 3.7. *fanya chini* terrace in Kibungo village

Tree nurseries were established to supply trees for agro-forestry and afforestation projects in the study villages (Figure 3.8). Agro-forestry is implemented in areas with slopes ranging from 0% to 15% where perennial trees are deliberately integrated with landholders' home gardens where the majority of farmer's plant different annual and perennials crops such as spice trees (cinnamon), banana and bread fruit trees. Trees provide timber, fuel wood, fruits and some trees can provide fodder for livestock and improve soil fertility. Together with grasses in rows, trees planted in macro contour-lines help to reduce the speed of surface runoff and retain sediments carried by surface runoff. Afforestation is implemented on lands with slopes above 35% considered not suitable for cultivation or grazing purposes. When growing crops, farmers are encouraged to use cover crops and mulching to improve soil moisture and productivity. In addition, the program emphasises the management of riparian

zones by planting trees to reduce surface run-off and soil erosion. These measures are believed to contribute to the conservation of watershed services and to support improvements of livelihoods for the stewards in terms of increasing farm yields to ensure food security and increased cash incomes.

Figure 3.8 shows a tree nursery in Kibungo Village



Figure 3.8. A tree nursery in Kibungo Village

3.5.9.2 Payment Arrangements and Modalities

Channelling PES payments to farmers in return for the provision of services is intended to motivate more local farmers to engage effectively in improved land use practices. The EPWS payments are provided to individual farm owners on the basis of land size and technology applied. As different farmers apply different practices such as bench terraces, *fanya juu/chini*, agro-forestry, reforestation, grass stripping and riparian restoration, the payments for these technologies are determined by their labour inputs and opportunity costs (for loss of production).

To ensure successful payments and fairness, all converted farms with improved practices were measured and mapped using GPS and GIS applications to verify land sizes and method/s applied. Farmers were involved during GPS measurement and they signed the data collection tool to show they agreed. Payments for the adoption of various SLM practices were differentiated according to their establishment costs and opportunity costs. The “opportunity cost was calculated in consultation with community members and was related to agricultural income for main crops linked to area removed from production for each technology. This was agreed to be USD 128 per ha” (Lopa et al., 2012: 41). Also, “communities were consulted to obtain the local Labour Day market price, which was USD1.2 per day. This was then multiplied by the number of labour days required for respective action” (Lopa et al., 2012: 41). Table 3.8 and Table 3.9 present labour and opportunity costs used to determine the compensation amounts.

Table 3.8. Adoption costs of sustainable land management practices in Kibungo Sub-Catchment over the 4-year pilot EPWS implementation period (2008 – 2011)

Technology	Land removed from productive use in 1st year (%)	Loss associated from removing land from productive use (USD ha⁻¹)	Labour (days ha⁻¹)	Labour costs (USD ha⁻¹)	Total costs (USD ha⁻¹)
Bench terrace	100	128	140	168	296
Fanya juu	20	26	104	124	151
Reforestation	100	128	50	60	188
Agro-forestry	17	22	9	11	33

Source: Lopa et al. (2012)

Table 3.9. The EPWS establishment costs, maintenance costs and opportunity costs for the adoption of SLM practices in Kibungo Sub-Catchment piloted between 2008 and 2011

	Establishment Costs in Year 1	Maintenance costs Year 1-4	Opportunity costs Year 1-4	Total costs over 4 Years
	US\$/ha	US\$/ha/year	US\$/ha/year	US\$/ha
Afforestation, reforestation	87	76	756	3,415
<i>Kilaka</i> terraces (with agro-forestry and grass strips)	334	192	1,058	5,334
Pineapple contours (with agro-forestry and grass strips)	58	116	176	1,226
<i>Fanya Juu</i> terraces (with grass strips)	320	38	44	648
Riparian restoration, sugar cane planting, tree planting	8	40	58	400

Source: CARE and WWF 2008

In their agreements with CARE/WWF, the village authorities of Kibungo Juu ward are required to ensure the implementation and maintenance of introduced SLM measures. In return, CARE/WWF makes payments to farmers on behalf of DAWASCO for the work done by the farmers (Figure 3.9) (Lopa and Mwanyoka, 2010)

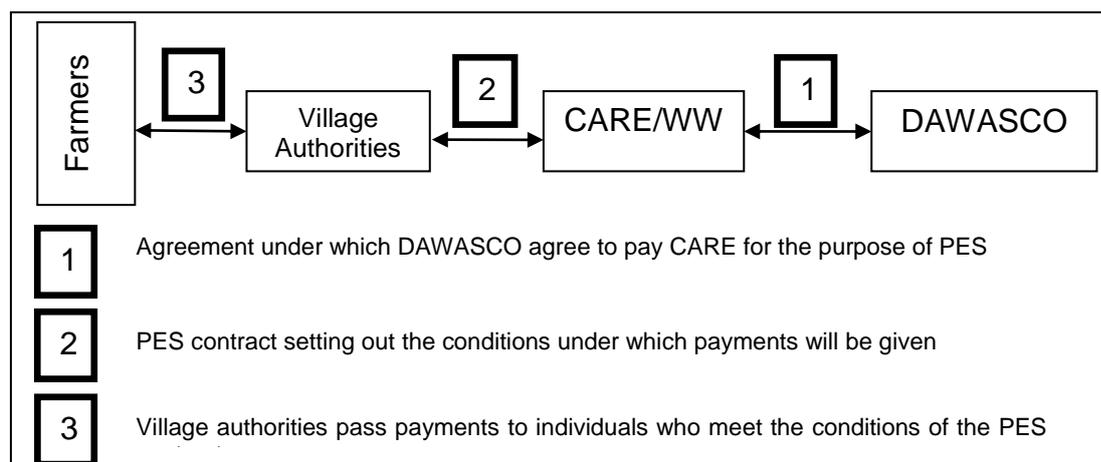


Figure 3.9. EPWS transaction structure linking sellers to buyers via CARE/WWF

Source: Adapted from Lopa *et al.*(2012)

For future management and up-scaling of EPWS practices, the intermediary organisation, CARE-WWF facilitated the establishment of an Intermediary Group (IG) that includes representatives of service sellers (project implementing village members), service buyers (DAWASCO and Coca Cola Kwanza Ltd), government agencies and community based organizations to take the lead in the EPWS program and to scale it up to cover other catchments in the Uluguru Mountains when the role of CARE-WWF Tanzania in the pilot project comes to an end.

3.5.10 Livelihood Patterns in the Case study Villages

This section provides the profile of the study villages. It includes a description of the social and economic activities undertaken by the households in the study villages.

3.5.10.1 Land Ownership

A study conducted by CARE and WWF (2007b) shows that the nature of land tenure system in Nyingwa, Dimilo, Lanzi and Kibungo villages is dual; the village government and the customary land user rights. Of these the dominant land tenure system in the area is the village government (council) land user right in which the village council is the allocating authority. While the villagers only have a derivative right to use and occupancy, once they have been allocated land and developed it, the customary land user right operates (CARE and WWF, 2007b). A land with customary user rights can be accessed by clan members through inheritance and by non-clan members through renting or sale. In addition, the report also shows that the land is increasingly becoming a major constraint to agricultural production and food security where the available agricultural land per household has been declining due to increase in population. Most households

own small plots with no possibilities of increasing production through land expansion.

The findings of this study that focused on Kibungo, Nyingwa, Lanzi and Dimilo villages show that at the household level, landholding amounts to 3 acres with large variance (St. Dev. 1.4), whereby more than half (66.1%) of households owned between 1 and 3 acres. Also, 14.2% owned less than 1 acre while 19.7% of all households owned farms larger than 3 acres and only 4.5% owned between 5 and 6 acres of land. The comparison of land distribution between the four villages shows that households in Lanzi and Nyingwa villages (3.3 acres and 3 acres respectively) are comparatively richer in land ownership than Dimilo and Kibungo villages (2.3 and 2.7 acres respectively) (see Table 3.10). Almost all the land is cropland, and there are just few plots with forest on it.

Table 3.10. Land ownership in the study villages

	Kibungo	Nyingwa	Dimilo	Lanzi	Total
Minimum	0.25	0.25	0.50	0.25	0.25
Maxmum	6.00	6.00	6.00	6.50	6.50
Mean	2.70	3.00	2.30	3.30	3.00
Std. Deviation	1.40	1.30	1.30	1.40	1.40

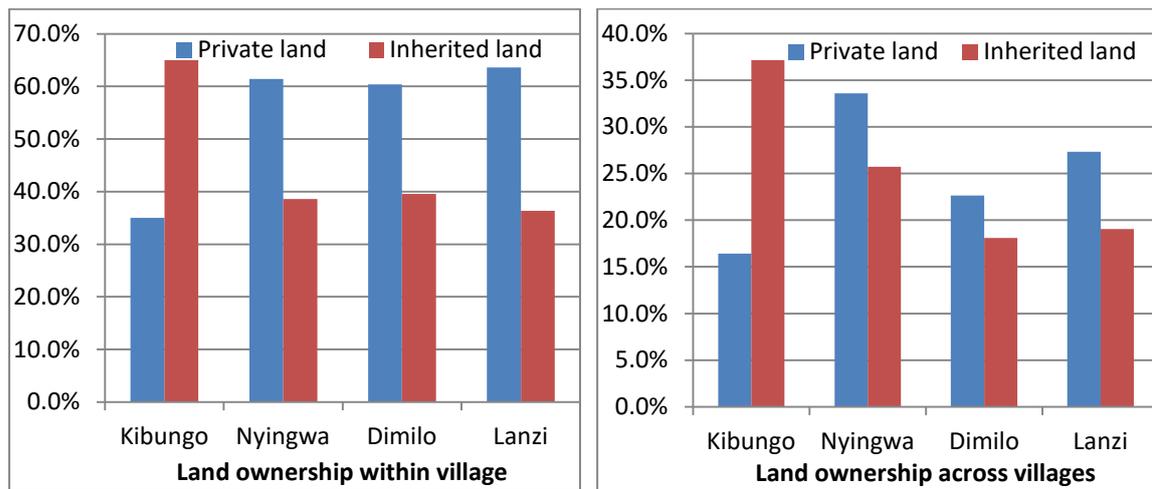


Figure 3.10. Type of land ownership within and across villages in the study villages

With respect to the method of land acquisition in the study villages, 54.9% of households purchased their land or were allocated by the village and 45.1% households inherited the land. The comparison of land ownership within the study villages shows that most households in Kibungo village own inherited land while for Nyingwa, Dimilo and Lanzi most households own private land. This same trend is exhibited across study village comparison (Figure 3.10). Further information about land acquisition shows that the majority of households (97% and 98%) use their land for crop production activities while only few (2% and 3%) use their land for forest activities. Land titles are important information about land in the study villages. Interviews with the village leader showed that about 75% of households have customary right of ownership while 25% have village ownership rights. The interviews and focus group discussions further revealed that SLM practices (i.e. terracing) were being implemented on private lands – mostly home gardens.

3.5.10.2 Housing Condition

During the wealth ranking exercise, villagers identified types of bricks (burned or not burned) and other materials used for housing; and this was used as one of the household indicators of wealth. Iron sheets for roofing and brick walls are considered to indicate relative wealth compared to houses constructed from mud and grass materials for roofing. Across study villages, rich people were identified by houses with burned bricks combined with iron sheets and mud flooring. Middle income people used the same materials but unburned mud bricks while the poor relied on the old-fashioned poles and mud wall construction with grass roofing. Table 3.11 shows the different materials for walls, roofing and flooring used in the study villages. Dimilo village had slightly lower occurrence of iron sheets for roofing and Kibungo village had the highest. Kibungo and Nyingwa villages had the highest number of respondents with houses that were made from mud bricks while Dimilo and Lanzi villages had the highest number of respondents with houses that were made from poles.

Table 3.11. Housing materials used by study village and for the entire sample

	Kibungo	Nyingwa	Dimilo	Lanzi	Total
Type of walls					
Stone with plaster	1.7	0.0	2.1	1.8	1.3
Stones and mud	13.6	5.7	6.3	3.6	7.3
Burnt bricks with plaster	1.7	7.1	2.1	3.6	3.9
Burnt bricks	1.7	0.0	0.0	3.6	1.3
Mud bricks with plaster	8.5	8.6	0.0	9.1	6.9
Mud bricks	61.0	54.3	27.1	38.2	46.6
Poles and mud	11.9	24.3	62.5	40.0	32.8
Type of roof					
Thatch/Leaves	47.5	54.3	61.7	60.0	61.6
Metal sheets	52.5	45.7	38.3	40.0	38.4
Type of floor					
Cement	10.5	7.5	4.2	18.2	9.3
Mud/dust	89.5	92.5	95.8	81.8	89.9

The building material used was not significantly different between female or male household heads (Table 3.12). More female heads of households (53.8%) lived in brick houses than did male heads of households (42.8%). Also, more male household heads (36.2%) lived in houses made from poles and mud than did female household heads (26.3%). As for roofing, 63.3% of female and 61.8% male heads of households had thatched houses. Also, 38.8% female and 38.2% of male heads of households used iron sheets as roofing material for their houses. Almost 11.7% more female heads of households lived in houses with cement floor as compared to 9.3% heads of households.

Table 3.12. Housing material by gender of household head

	Household Head	
	Female	Male
Type of walls		
Stone with plaster	1.3	1.3
Stones and mud	6.3	7.9
Burnt bricks with plaster	5.0	3.3
Burnt bricks	1.3	1.3
Mud bricks with plaster	6.3	7.2
Mud bricks	53.8	42.8
Poles and mud	26.3	36.2
Type of roof		
Thatch/Leaves	61.3	61.8
Metal sheets	38.8	38.2
Type of floor		
Cement	11.7	9.3
Mud\dust	88.3	90.7

3.5.10.3 Education and Social Services

With regard to the educational level, 25.3% and 63.9% of household heads were educated at standard four and standard seven level of education respectively. Fewer males headed households had between standard 1 and 4 (22.4%) level of education compared to female head of households (30.9%). Also, more males had the level of education between form one to form six (Figure 3.11).

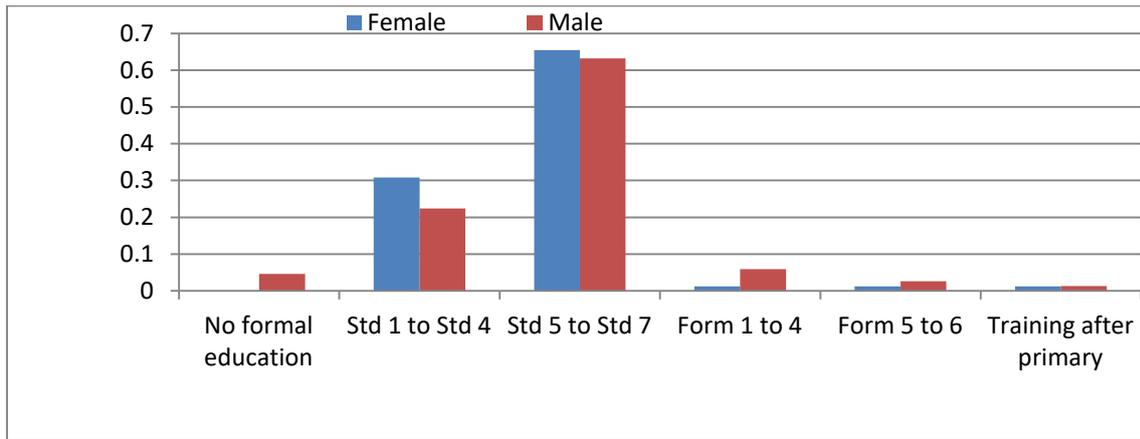


Figure 3.11. Differences in education between male and female headed household

Only Kibungo village had fewer household heads with standard four to standard seven level of education (Figure 3.12). Other villages had more than 65% heads of households with standard four to standard seven level of education. The percentage of households with no formal education was highest in Kibungo and Dimilo villages with 3.3% and 6.3% respectively.

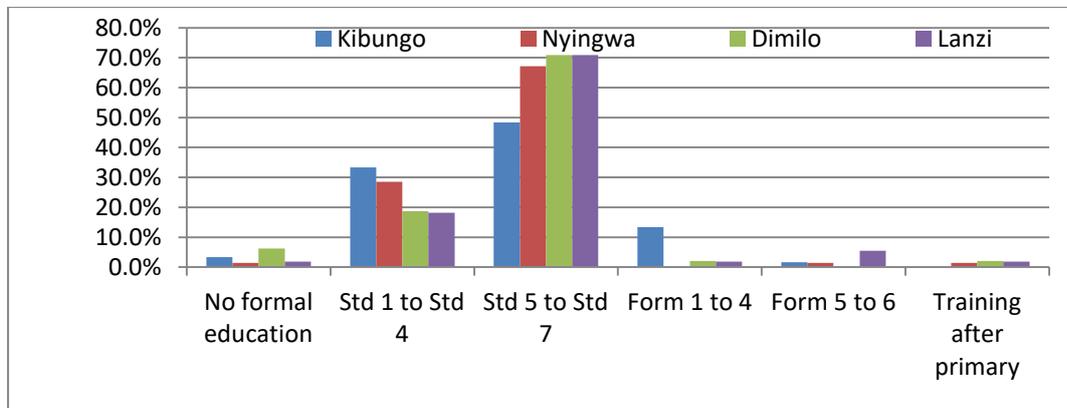


Figure 3.12. Education of HH head by study village

The comparison between education and wealth group across study villages showed that of the poor wealth group none had post standard seven level of education while there was 9.4% of middle and 15.%% of higher wealth group who had post standard seven level of education (Figure 3.13). The social services and

infrastructure provided at communal level influence as part of the social capital the livelihoods of individual households. In all study villages, there was similar with some slight variations in the social services situation. Kibungo and Lanzi villages were relatively well serviced due to their road access compare to Nyingwa and Dimilo villages which were remote with poor road access. None of the villages had electricity. Although no village had piped water, water was not considered to be the main problem in the villages. The main source of water in almost all study villages was natural springs (65.7%) and river/streams (25.8%). In all villages, water was everyday available (96%) from these sources. Also, the walking distance to the water source was less than ten minutes (75.4%).

The main source of energy for cooking in almost all households in the study villages was firewood (96%). Firewood was either collected from nearby forests or purchased. Charcoal was produced for sale and served as a source of income rather than household energy. Mobile phone communication was accessible in all villages. Usually, those villagers who could not afford to buy a mobile phone purchased phone services from some better off villagers (mostly younger men) who owned mobile phones.

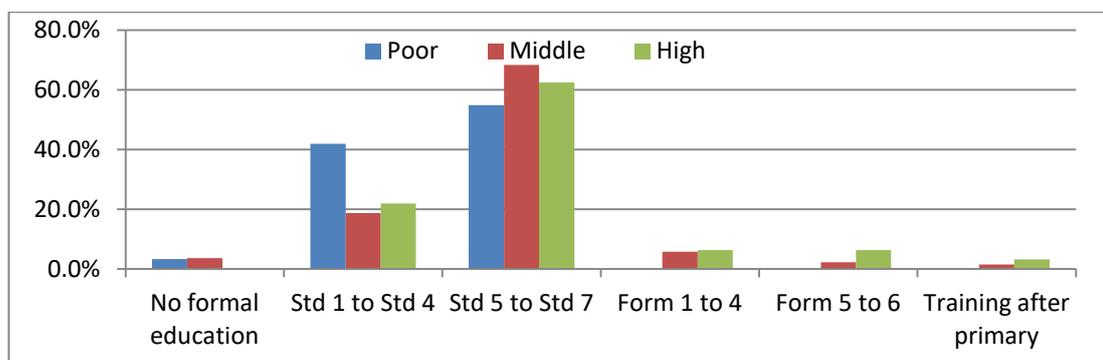


Figure 3.13. Education of HH head by wealth

In all four villages, the situation of health services varied slightly between the villages but was generally described as poor by the villagers. On average, many households take more than sixty minutes to get to health facilities in the village. Only households in Kibungo (78.3%) and Nyingwa (57.1%) villages recorded to take less than sixty minutes to health facility compared to Dimilo (6.3%) and Lanzi (34.6%) villages. Taking natural medicines from the forest or referring to traditional healers was common in all four villages.

3.5.10.4 Sources of Livelihood

The main source of household livelihoods in the study villages is agriculture combined with small scale businesses and small livestock keeping. Only teachers, health facility workers, village and ward executive officers and extension offices had formal employment. For people with smaller land holdings or without land, daily labour to other villagers with more income and larger farms was an important source of income. Traditionally, farming was the main source of livelihoods named by study village respondents (Figure 3.14). They also identified sells of crops as their main source of cash income (93.5%) followed by the sale of livestock such as chicken and goats (55.4%) and business (8.2%). While these sources were identified as the village's main source of cash income, deeper inquiry with the focus group discussions revealed that yields from the fields cultivated was too low to make a living due to unfavourable agricultural conditions (i.e. infertile soils and the lack of land, inputs, tools and extension services). They also revealed the existence of reliance on other sources of livelihoods, particularly forest resources such as timber and poles that some households harvest illegally in forest reserves.

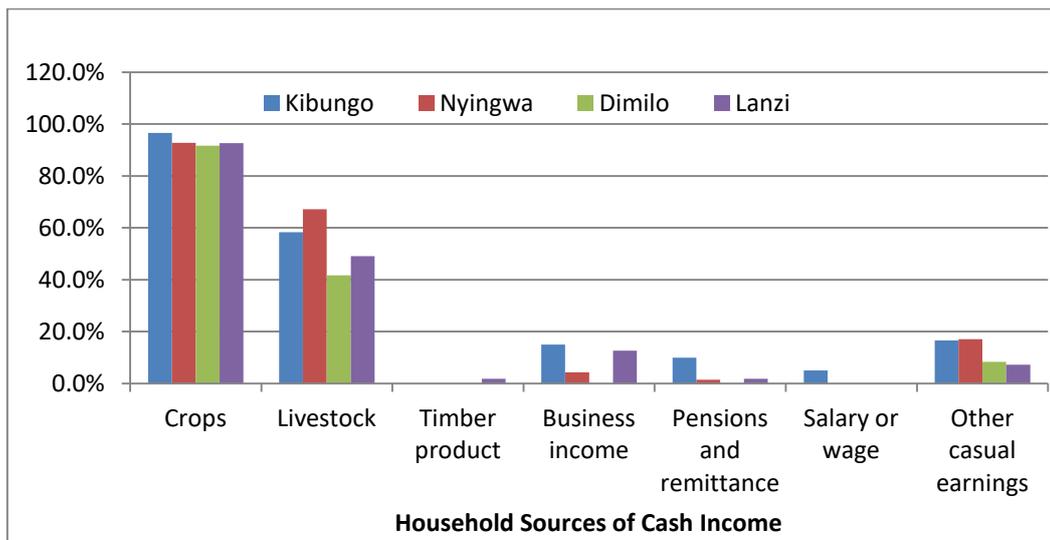


Figure 3.14. Household Sources of cash Income

Business income (8.2%), pensions and remittances (3.4%) and salary/wage (1.3%) played the most important role as non-farm sources of household income (Figure 3.14). 12.9% of respondents indicated other casual earnings such as beer brewing, house-building and charcoal burning as source of income. Timber and charcoal making were used by some households as their important source of cash income but barely mentioned as they were illegal activities that most respondents would not openly admit to conduct.

3.5.10.5 Household Asset Wealth

The wealth distribution across villages (measured in asset wealth) is shown in Table 3.13 below. Comparatively, Nyingwa village has the highest percentage of richer households (55.7%), followed by Lanzi village (54.5%) and Kibungo village (50.0%). Dimilo is the village that has the highest percentage of poorer households (44.7%), followed by Kibungo village.

Table 3.13. Relative wealth in the study villages (% of households in asset groups)

	Kibungo	Nyingwa	Dimilo	Lanzi	All
1.00 (poorer)	15	11	21	11	58
	25.0%	15.7%	45.8%	20.0%	25.0%
2.00	15	20	9	14	58
	25.0%	28.6%	18.8%	25.5%	25.0%
3.00	17	22	6	13	58
	28.3%	31.4%	12.5%	23.6%	25.0%
4.00 (richer)	13	17	11	17	58
	21.7%	24.3%	22.9%	30.9%	25.0%
Total	60	70	48	55	233
	100.0%	100.0%	100.0%	100.0%	100.0%

The full list of assets owned by the households and the frequency is shown in Table 3.15. The assets were grouped into four asset categories: land assets, non-productive assets, productive assets and livestock assets. Table 3.14 shows the mean value of assets in TSH for the four categories disaggregated by wealth group. Wealth group 4 (richer) had the highest mean values for all four asset categories.

Table 3.14. Value of assets in TSH by household, mean values

Assets		Low wealth assets group		High wealth assets group	
		1 (poorer)	2	3	4 (richer)
Land assets	Mean	277,414	500,862	743,103	1,137,931
	Median	220,000	525,000	800,000	1,200,000
Non Productive assets	Mean	103,88	137,238	152,907	188,416
	Median	95,550	135,250	143,700	185,750
Productive assets	Mean	23,776	28,526	63,060	184,707
	Median	15,000	20,500	24,000	33,250
Livestock assets	Mean	48,974	111,940	190,552	351,931
	Median	40,000	67,000	149,000	285,500
					1,862,984
Total value of Assets	Mean	454,048	778,566	1,149,622	
	Median	370,550	747,750	1,116,700	1,704,500

Table 3.15. Assets owned by the sample households

Asset	N	Percent	Average owned
Chicken	163	70.26	12
Goat	137	59.05	5
Pig	73	31.47	3
Sheep	10	4.31	3
Machete	173	74.57	1
Hand hoe	204	87.93	2
Axes	132	56.90	1
Sickle	158	68.10	2
Mobile phone	117	50.43	1
Chairs	184	79.31	3
Tables	198	85.34	2
Beds	227	97.84	2
Mosquito net	162	69.83	2
Iron charcoal	77	33.19	1
Radio	132	56.90	1
Motorcycle	5	2.16	1
Bicycle	14	6.03	1
Sewing machine	9	3.88	1
Buckets	231	99.57	3
Beehives	7	3.02	3
Spade	145	62.50	1
Cooking port	232	100.00	3
Flour milling machine	5	2.16	1
Generator	7	3.02	1
TV	9	3.88	1

3.5.10.6 Gender and Relative Wealth

The sample included 34.9% female and 65.1% male heads of household (Table 3.16). Village wise, Kibungo village (41.7%) had largest representation of female headed households and Lanzi village the smallest (30.9%) (Table 3.16). While, more female (96.3%) than male household heads (85.4%) had achieve standard one to seven, more males (9.9%) than female household heads (3.7%) had gone beyond standard seven to between form one and six and attended training after standard seven (Table 3.16).

Table 3.16. Respondents, heads of households, education, study villages and asset quartile by gender

		Male (%)	Female (%)
Heads of households		65.1	34.9
Education	Std 1-7	85.4	96.3
	Form 1-6 and training standard 7 after	9.9	3.7
Gender of household head between and within villages ()	Kibungo	23.2 (58.3)	30.9 (41.7)
	Nyingwa	31.1 (67.1)	28.4 (32.9)
	Dimilo	20.5 (66)	19.8 (64)
	Lanzi	25.2 (69.1)	21 (30.9)
Gender of household head by asset quartile group	1 (poorer)	53.4	46.6
	2	65.5	34.5
	3	62.1	37.9
	4 (richer)	79.3	20.7

The majority of male headed households were in the highest asset category. The asset nets in Figure 3.15 below (mean values in TSH in Table 3.17) show that male headed households had on average larger asset wealth than female headed households.

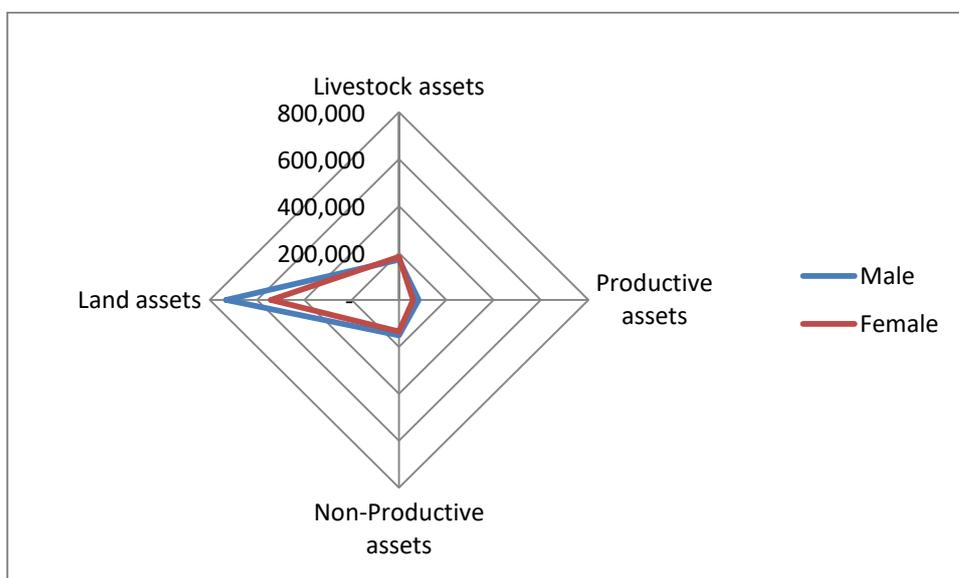


Figure 3.15. Asset nets (mean values in TSH) by gender of household head.

Table 3.17. Asset categories, mean values and standard deviation (SD) in TSH, by gender of household head

	Male (SD)	Female (SD)
Livestock assets	171,632 (199,140)	183,709 (213,686)
Productive assets	83,307 (242,565)	59,561 (190,588)
Non-Productive assets	151,535 (57,740)	134,567 (60,781)
Land assets	731,059 (391,522)	541,358 (371,129)

3.6 The Propensity Score Matching and the Implementation

Propensity score matching (PSM) is a statistical matching technique that attempts to estimate the effect of a treatment, policy, or program by accounting for the covariates that predict receiving the treatment (Caliendo and Kopeinig, 2008; Austin, 2011; Peikes et al., 2012). In this study, PSM technique was used to construct a statistical comparison group based on balancing scores $b(X)$ of the probability for an individual to participate in a treatment given his/her observable covariates X unaffected by the program, such that the conditional distribution of X given $b(X)$ is independent of assignment into treatment (Rosenbaum and Rubin, 1983; Rosenbaum, 2002; Caliendo and Kopeinig, 2008). This probability or propensity score is then used to match EPWS program participants to non-EPWS participants. The average treatment effect of the program is then calculated as the mean difference in outcomes across the two groups (Rosenbaum and Rubin, 1983; Rosenbaum, 2002). This counterfactual condition establishes what would have happened to livelihoods of participants if there had been no EPWS program intervention. As described in section 3.2.3, being an observational quasi-experimental evaluation study, the validity of PSM depends on (a) conditional independence (namely, that unobserved factors do not affect participation) and

(b) the presence of sizable common support or overlap in propensity scores across the EPWS participants and non-EPWS participants to reduce selection bias (Rosenbaum, 2002). Figure 3.16 summarises the steps followed in PSM.

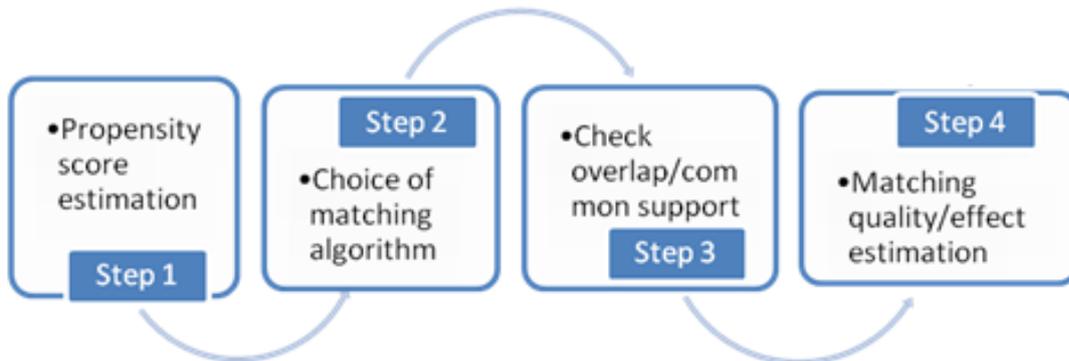


Figure 3.16. Propensity score matching implementation steps.

Source: Adopted from (Rosenbaum, 2002) page. 2

The choice of the model to be used for estimation of propensity score and the variables to be included in the model are two important choices that need to be made when using PSM (Dehejia and Wahba, 2002; Rosenbaum, 2002). In this study, the logit model of program participation was used to estimate probabilities or propensity scores. Any discrete choice model can be used for estimating propensity scores because logit and probit models yield similar results when estimating the probability of participation vs. non participation in binary treatment cases (Rosenbaum, 2002). In the general framework of the probability model we have: $Prob(\text{EPWS participation}) = Prob(D=1) = F[\text{relevant effects, parameters}]$. In this case, the probability of participation in EPWS is a cumulative distribution function F evaluated as a function of a set (X) of explanatory variables that include household socio-economic characteristics, and a vector β of unknown parameters. The probability of participation model can be written as:

$$Prob(D_i = j) = \frac{e^{\beta x_{ij}}}{e^{\beta x_{i0}} + e^{\beta x_{i1}}} \text{ for } j = 0, 1 \dots \dots 6.9$$

As emphasised by Smith and Todd (1983), the choice of variables used for building up the propensity score model were based on sound knowledge of previous research and those unaffected by participation or anticipation of it (Rosenbaum, 2002; Caliendo and Kopeinig, 2008). The variables included in the propensity score estimation model are household head's gender, age and education, household family size, farm size of the household and household's past land use. To make sure the bias in PSM program estimates is low; the same survey instrument was administered to participants and non-participants from the same geographical area facing the same economic incentives (i.e. that might be drive choices such as program participation) to ensure that the observed characteristics entering the logit model of participation are measured similarly across the two groups (Heckman et al., 1999; Dehejia and Wahba, 2002; Ravallion, 2007; Caliendo and Kopeinig, 2008).

Nearest neighbour (NN) matching with replacement estimator (i.e. an untreated individual was used more than once as a match) was used to trade-off bias and variance (Dehejia and Wahba, 2002; Caliendo and Kopeinig, 2008). By allowing replacement, the average quality of matching was increased and the bias decreased (Dehejia and Wahba, 2002). This approach was vital in this study because, the propensity score distribution in the data between the treatment and the control group was slightly different. This could reduce the number of distinct non-participants used to construct the counterfactual outcome and increase the variance of the estimator (Rosenbaum and Rubin, 1983; Dehejia and Wahba,

2002). Matching with replacement allowed the reduction of bias, by producing matches of higher quality than that could have been achieved with matching without replacement, given the lower number of control observations (Dehejia and Wahba, 2002; Scales, 2015).

Visual analysis of histograms (Figures 3.17 and 3.18) showing density distribution of the propensity score in the two groups was used to check the overlap and the region of common support assumption (Caliendo and Kopeinig, 2008). This ensured that any combination of characteristics observed in the treatment group can also be observed among the control group (Caliendo and Kopeinig, 2008). In NN matching with replacement, only the closest neighbour from control group is used to match treatment individuals. Control individuals that fall outside the region of common support were discarded as bad matches (Rosenbaum and Rubin, 1983). The region of common support before NN matching with replacement is shown in Figure 3.17 while Figure 3.18 shows the region after NN matching with replacement.

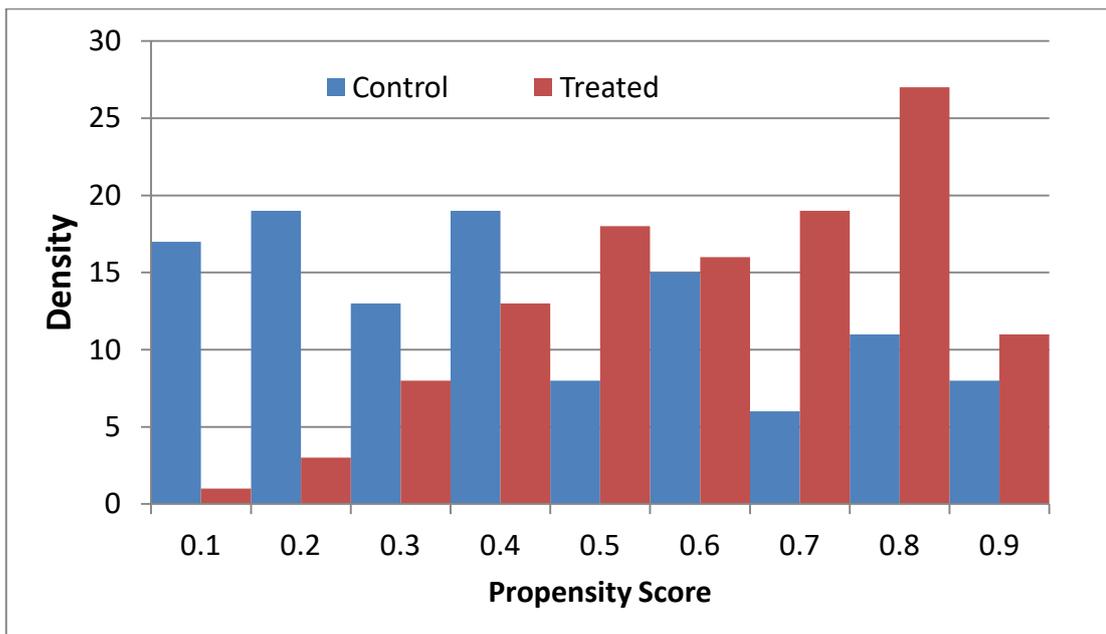


Figure 3.17. Region of common support before NN matching

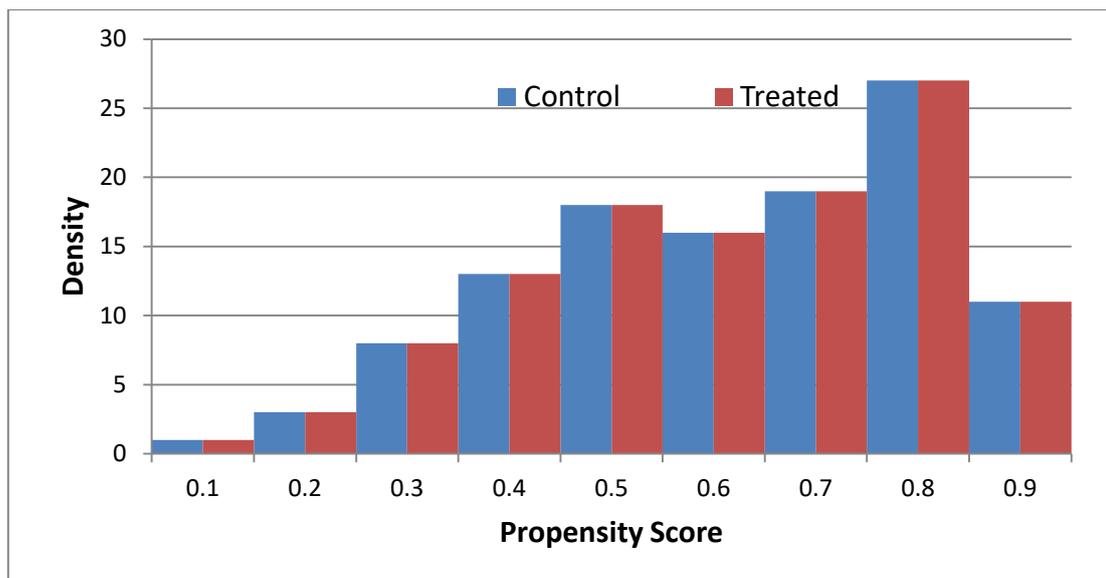


Figure 3.18. Region of common support after NN matching with replacement

The quality of matching in terms of characteristics of the treatment and control group before and after matching is presented in Table 3.18 and 3.19 respectively. They also show observable socio-economic characteristics used for matching that had the potential to influence participation or selection into the EPWS program (Ravallion, 2007; Caliendo and Kopeinig, 2008). Before matching, the

sample shows that the heads of participating households are younger than non-participants and that they have more years of schooling. The participating households also have more members and land. Indeed, the Mann-Whitney U test shows significant difference between the treated and control group (Table 3.18). After matching (Table 3.19), treatment and control groups are similar in terms of propensity scores because Mann-Whitney U test shows no significant difference between the two groups.

Table 3.18. Comparison of pre-matched samples of EPWS program participants and non-participants

Names of Variables	Treatment Condition	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t-test
Gender of household head¹	Yes	0.72	0.45	0.04	0.14	2.31 *
	No	0.58	0.49	0.05		
Age of household head	Yes	43.7	13.26	1.23	-7.99	-4.17**
	No	51.7	15.89	1.49		
Household size	Yes	2.53	0.93	0.09	0.52	3.74**
	No	2.01	1.17	0.11		
Years of schooling of the household head	Yes	6.49	1.61	0.15	0.94	3.90**
	No	5.55	2.06	0.19		
Farm size (acres)	Yes	3.55	1.44	0.13	1.08	6.12**
	No	2.47	1.26	0.12		
Past land use (conservation practices)¹	Yes	0.54	0.5	0.05	0.16	2.45*
	No	0.38	0.49	0.05		

Yes = Treated (EPWS program participants) and No = Control (EPWS program non-participants)
¹Indicates a dummy variable, coded as 1=statement true for respondent, and 0= statement false for respondent; the mean for these variables is therefore a percentage of respondents. Gender of household head: 1 if male and 0 if female; Past land use: 1 if implemented conservation practice in the past before EPWS program and 0 otherwise. The last column shows t-statistics, where single, and double asterisks (*) indicate that the means of the groups significantly differ from each other at the 5%, and 1% levels of probability, respectively.

Table 3.19. Comparison of matched samples of EPWS program participants and non-participants

Names of Variables	Treatment Condition	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t-test and significance
Gender of household head ¹	Yes	0.74	0.44	0.04	-0.05	-0.93
	No	0.79	0.41	0.04		
Age of household head	Yes	44.67	12.92	1.20	1.87	1.14
	No	42.80	12.13	1.13		
Household size	Yes	2.66	1.13	0.10	-0.05	-0.35
	No	2.72	1.13	0.10		
Years of schooling of the household head	Yes	6.92	2.12	0.19	0.03	0.09
	No	6.90	2.11	0.19		
Farm size (acres)	Yes	3.52	1.43	0.13	0.13	0.73
	No	3.39	1.23	0.11		
Past land use (conservation practices) ¹	Yes	0.55	0.49	0.05	-0.01	-0.13
	No	0.56	0.49	0.05		

Yes = Treated (EPWS program participants) and No = Control (EPWS program non-participants)

¹Indicates a dummy variable, coded as 1=statement true for respondent, and 0= statement false for respondent; the mean for these variables is therefore a percentage of respondents. Gender of household head: 1 if male and 0 if female; Past land use: 1 if implemented conservation practice in the past before EPWS program and 0 otherwise;

3.7 Conclusions

This chapter has justified the use of a case study approach and described the selection of the case study. It also describes the study site and the EPWS program. The methodological approaches to the evaluation of the EPWS program, data collection methods, field experience and data analysis methods have been explained. Having described how the various data were collected and analysed, the following chapters (Chapters 4–6) present the findings from this study. In each of the result chapters, specific materials and methods are explained.

Chapter 4: Farmer Participation in the Equitable Payments for Watershed Services in Morogoro, Tanzania

4.1 Chapter Outline

This chapter examines participation in the EPWS program and the determinants of farmers' decision to participate in the program. The chapter uses mixed methods with logistic regression method to investigate factors that determine farmers' decision to participate in the program in order to shed light on the factors that will determine participation in an agricultural based PES program. Results highlight that eligible poor households participate in the EPWS program and their participation is not limited to simpler practices but they also construct terraces. Also, farm size, farmers' access to information, participation in the design phase of the program and the change in farm management required by the program significantly determine farmer participation in the EPWS program. The results highlight the need to carefully design PES schemes in developing countries that take into consideration farm size, access to information, and other obstacles that constrain the participation of the poor.

4.2 Introduction

The development of PES programs on agricultural lands is receiving increasingly serious attention in developing countries (Branca et al., 2011; FAO, 2007b; Ribaud et al., 2010). However, whilst there has been some proliferation of research on PES in developing countries, there remains a gap in empirical evaluations that assess the participation of poor households and factors that determine participation decision in PES programs implemented on agricultural

land to address conservation and development objectives in developing countries. The development of PES interventions in developing countries faces significant challenges because of weak institutions, missing markets (Muller and Albers, 2004; Rios and Pagiola, 2009), high incidence of poverty, insecure land tenure, demand side limitations and supply side dynamics (Ferraro, 2009; Wunder, 2007). This suggests that farmers in agricultural land based PES programs could face complex decisions on whether to adopt land uses promoted by them, taking into account the key hallmarks of PES – the voluntary transactions and conditional payments (Wunder, 2005, p.3).

This chapter seeks to narrow the above gap by empirically evaluating participation of the poor households and the determinants of farmers' decision to participate in the EPWS program which is one of PES programs implemented on agricultural land to achieve conservation and development goals in developing countries. Most of the existing studies focus on China (Ferraro, 2009; Grosjean and Kontoleon, 2009; Uchida et al., 2007) and Latin America (Echavarría, 2002; Pagiola, 2008; Pagiola et al., 2005; Pagiola et al., 2007; Pagiola et al., 2010; Wunder and Albán, 2008), particularly on forest based PES programs financed by governments and international organisations.

Most PES programs in developing countries are expected to contribute to poverty reduction by making payments to poor land users (Pagiola et al., 2008; Pagiola et al., 2010). Determining whether poorer households are participating is thus vital, if PES programs are to add to poverty reduction objectives. Also, since a PES program can only generate benefits to those households that participate and

supply the desired services (Pagiola et al., 2008; Pagiola et al., 2010), understanding of the factors that determine participation in the program is critical. Pagiola et al. (2005) categorise factors that can determine a farmers' decision to participate in a PES program into factors that affect eligibility to participate; factors that affect a households' desire to participate; and factors that affect their ability to participate. These categories form a logical sequence which suggests that the ability to participate becomes an issue for households that are eligible to participate (Pagiola and Platais, 2005).

Participation requires households that are eligible to participate to adopt land uses promoted by the program. Adopting these new land uses can be straightforward or complex depending on whether the program calls for retaining existing land uses or switching to new practices (Pagiola et al., 2007). The literature on program participation, technology adoption and adoption of agroforestry practices provide useful insights into the factors likely to determine PES program participation decision (Pattanayak et al., 2003; Pagiola et al., 2008; Pagiola et al., 2010). This literature indicates that factors influencing households' participation decisions can be grouped into farmer and farm characteristics, program factors, and the institutional context of the program (Brotherton, 1989; Knowler and Bradshaw, 2007; Kosoy et al., 2008; Pagiola et al., 2007; Wauters et al., 2010; Wilson, 1997; Yiridoe et al., 2010; Zbinden and Lee, 2005). First, farm and farmer characteristics include age and education of a household head, which often determine the ability to obtain and process information and implement knowledge intensive conservation practices (Azizi Khalkheili and Zamani, 2009; Kosoy et al., 2008; Mullan and Kontoleon, 2009). Other farm and

farmer characteristics include land tenure (Schuck et al., 2002), labour availability (Zbinden and Lee, 2005), access to information (Mullan and Kontoleon, 2009), opportunity cost of land and expected impacts on the household income (Wunder, 2006).

Second, program factors include program targeting (Mullan and Kontoleon, 2009; Wünscher et al., 2008), conditionality (Kosoy et al., 2008), size of incentives, information flow, participatory nature of program design (Biggs and Farrington, 1991) and expected changes in farm management introduced by the program (Brotherton, 1989; Mullan and Kontoleon, 2009; Pagiola et al., 2005; Wünscher et al., 2008). Third, factors related to the wider institutional context include tenure systems in the area of project implementation (Pagiola et al., 2007; Pagiola et al., 2008), access and availability of credit to finance conservation practices (Miranda et al., 2003), and social and cultural values such as the importance of non-timber products to households, which may influence the land owners willingness to participate in conservation programs (Corbera et al., 2009; Kosoy et al., 2008).

This chapter uses both quantitative and qualitative methods to explore the participation of poor households in the EPWS program and how farm and farmer characteristics, program factors and institutional contexts determine farmers' decisions to participate in the program. This mixed method approach helps to counteract a naïve rational choice view that farmers consider only costs and benefits when deciding whether or not to participate in a program (Kosoy et al. 2008). The research focuses on the Equitable Payments for Watershed Services

(EPWS) program piloted in the Kibungo Juu ward in Morogoro, Tanzania as a case study (illustrated in chapter 3). The next section describes the material and methods used for the chapter.

4.3 Material and Methods

This chapter follows the generic descriptions of methods described in Chapter 3. For the purpose of achieving the specific chapter objective in examining the participation of poor households in the EPWS program and factors that determine participation decision, key informant interviews, focus group discussions and household survey were used in the collection of qualitative and quantitative data. The collection and analysis of the quantitative data was informed by the assumptions of the neo-classical production theories (Horowitz, 1970; Rahm and Huffman, 1984). These theories operate on the assumption that a farmer (i.e. an individual or a household) is a profit maximizing entity that chooses an optimal resource allocation over a period of time, given the available resources (land, labour, capital) and subject to natural and institutional constraints (Zbinden and Lee, 2005). As such, adoption of agro-environmental technologies or program participation takes a binary decision whereby a farmer enters the program if the utility of doing so exceeds the utility of not doing. Consequently, a binary logistic regression model is used to assess decisions of this type on the basis of a set of explanatory variables (Ayuk, 1997; Adesina et al., 2000; Adesina and Chianu, 2002; Thangata and Alavalapati, 2003).

Based on previous research on the economics of technology adoption, forestry and farm program participation, the utility of participation is a function of two vectors \mathbf{Z} and \mathbf{X} ,

$$U_i^p = V(\mathbf{Z}_i^p \mathbf{X}_i) + \varepsilon(\mathbf{Z}_i^p, \mathbf{X}_i, e_i^p)$$

where \mathbf{p} denotes participation (1 if yes; 0 if no), and \mathbf{V} stands for a vector of unobservable parameters. Vector \mathbf{V} is broken down into \mathbf{Z} and \mathbf{X} vectors. Vector \mathbf{Z} represents economic attributes associated with the program, while \mathbf{X} denotes socioeconomic attributes of the individual farmer (decision maker). While, attributes of \mathbf{Z} are endogenous to the decision to participate, \mathbf{X} attributes are typically exogenous. To put it more formally,

Participation: $P_i = 1$ if $U_i^0 < U_i^1$,

Non-participation: $P_i = 0$ if $U_i^0 \geq U_i^1$.

The probability of participation can be derived from the above utility function and a specific probability model can be developed. The probability of participation $\Pr(P_i = 1)$ is a cumulative distribution function of \mathbf{F} evaluated as a function of a set (\mathbf{X}) of explanatory variables and vector β of unobservable parameters. The logistic cumulative distribution function is the basis for the logit regression model(s) used in this research, where the probability of participation can be modeled as

$$\text{Prob}(Y_i = j) = \frac{e^{\beta x_{ij}}}{1 + \sum_{k=1}^J e^{\beta x_{ik}}} \dots \dots \dots (1)$$

for $j = 0, 1, 2, \dots, J$,

where J is the number of choices. Greene (2000) shows that the multinomial case ($J > 1$) is just an extension of the binomial case ($J = 0, 1$). The actual

estimation form of the model is given after the logit transformation of the probability of participation and takes the following form:

$$\log \left[\frac{P_{ij}}{1-P_{ij}} \right] = \beta_j x_i. \dots\dots\dots (2)$$

In this chapter, a binary logistic regression model is used to model the determinants of a farmer's decision to participate in the EPWS program. Based on the illustrated framework, a farmer in the study area would choose EPWS program participation or non-participation subject to farm and ownership (i.e. farmer) characteristics, the program factors, and factors associated with the institutional context of the program (Brotherton, 1989; Ayuk, 1997; Wilson, 1997b; Lise, 2000; Thangata and Alavalapati, 2003; Zbinden and Lee, 2005; Kosoy et al., 2008; Mullan and Kontoleon, 2009; Yiridoe et al., 2010).

Explanatory variables used in the logistic regression equation are shown in Table 4.1. One of the variables considered to influence technology adoption or program participation decision is the gender (*gender*) of a household head (Adesina and Chianu, 2002; Thangata and Alavalapati, 2003). The role of women in most household farming and food activities is considered greater than that of men; yet, women are seen to have difficulty obtaining labour needed for land preparation activities due to inability to hire and finance external labour sources (Doss and Morris, 2000). The adoptions of SLM practices such as the construction of terraces are considered physically demanding as they require more labour. As such, the participation of women is hypothesised to be negative.

Another factor that can influence program participation decision or technology adoption is the age (*age*) of a household head which is considered a proxy for

experience (Zbinden and Lee, 2005; Knowler and Bradshaw, 2007). The age of a household head can be negatively linked to technology adoption because of bad experiences with past technologies, thus more risk averse and weak old age (Adesina and Chianu, 2002; Thangata and Alavalapati, 2003; Zbinden and Lee, 2005). Younger household heads are considered to be more risk takers, ambitious and energetic to try new technologies (Thangata and Alavalapati, 2003). In this study, younger household heads are expected to respond more positively to the adoption of SLM practices.

Years of the household head education (*educ*) are expected to be positively associated with the ability to obtain and process information and to successfully implement knowledge intensive conservation and agricultural technologies (Zbinden and Lee, 2005; Knowler and Bradshaw, 2007). This suggests that, household heads with low formal education are less likely to participate in or adopt SLM practices.

Household income can also influence technology adoption or program participation decision, because adopting new land use practices may prove difficult, if households cannot finance the necessary investment costs (Knowler and Bradshaw, 2007; Pagiola et al., 2008). As some practices in the EPWS program such as the construction of terraces and tree planting have some costs associated with them like manure and labour costs, the level of household assets as proxy for income (*income*) is hypothesised to have positive influence on the program participation decision.

Another factor hypothesised to influence technology adoption or program participation decision is the condition of household labour (Zbinden and Lee, 2005; Knowler and Bradshaw, 2007). Perceived short and long-term labour demands to implement technology can encourage or discourage technology adoption or program participation decision. In the EPWS program, the adoption of SLM practices such as the construction of terraces are labour intensive in the short term (Branca et al., 2009). Consequently, large household labour is hypothesised to positively influence participation whereby; the family size (*hsize*) variable is included in this study as the number of household members aged between 16 and 60 years. Household members aged below 16 are considered school going age.

Farm size managed by the farmer has been hypothesised to influence program participation or technology adoption decision (Knowler and Bradshaw, 2007). Specifically, farmers with larger land holding have been found to flexibly engage in new activities including innovative agricultural technologies (Lasley and Nolan, 1981; Nowak, 1987; Ayuk, 1997; Yiridoe et al., 2010). Also, larger farms are associated with greater wealth and increased availability of capital to make investment in conservation more feasible (Ur-Rehman and Chisholm, 2007). In this study, household farm size (*fsize*) is expected to be positively associated with EPWS program participation.

In communities with various types of land ownership (*landown*), land tenure is a critical determinant of program participation in cases where a program requires long-term investment such as terracing and tree planting (Sureshwaran et al., 1996; Pattanayak et al., 2003; Zbinden and Lee, 2005; Knowler and Bradshaw,

2007). Farmers tend to invest more on privately owned land than on rented or clan lands (Norris and Batie, 1987). Consequently, the study expects that farmers who own private land will participate more in the EPWS program than those with rented or clan lands.

Access to information (*info*) has been found to influence technology adoption and program participation decision (Wilson, 1997a; Knowler and Bradshaw, 2007). According to the findings by Adesina *et al.*, (2000) and Adesina and Chianu (2002) in Cameroon and Nigeria respectively, participation and adoption of soil and water conservation practices were higher to the farmers who had contact with change agents and access to information than their counterparts. In this study, participation in the EPWS program is hypothesised to be higher for the farmers who considered the program to be participatory (*participatory*) and had access to information and extension support before the program (*infor*).

Another factor that can influence technology adoption or program participation decision is the past experiences with conservation practices (Knowler and Bradshaw, 2007). In particular, farmers with past conservation experiences (*exluse*) and those with land use practices similar to new practices advocated by an intervention (*changeinfm*) were more willing to participate than those who did not have past experiences (Wilson, 1997a; Pattanayak *et al.*, 2003). In this study, more participation in the EPWS is expected among farmers who have implemented some conservation practices in the past and those with similar land use practices promoted by EPWS program.

On the basis of the hypothesised determinants of participation, the general form of the binary logistic regression equation is written as:

$$E(Y_i) = \alpha + \beta_1 \text{gender} + \beta_2 \text{age} + \beta_3 \text{educ} + \beta_4 \text{hhsiz} + \beta_5 \text{fsize} + \beta_6 \text{landown} \\ + \beta_7 \text{memberships} + \beta_8 \text{exluse} + \beta_9 \text{participatory} + \beta_{10} \text{changeinm} \\ + \beta_{11} \text{info} + \varepsilon$$

Where:

Y_i -is the dependent variable – participation.

α -is the constant.

β_s -are the coefficients of each explanatory variable.

ε -represents errors due to unobservable variables.

Table 4.1 shows the explanatory variables used in the logistic regression equation.

Table 4.1. The explanatory variables used in the logistic regression equation

Variable Name	Description	Expected Sign
gender	Gender of household head: 1 if male; 0 if female	-
age	Age of the household head	-
educ	Years of schooling of the household head	+
hhsiz	Number of working people in the household aged between 14 – 64 years old	+
fsize	A farm size of the household	+
landown	Household land tenure: 1 if own private land; 0 otherwise (i.e. rented).	+
memberships	Number of affiliations that the household has	+
exluse	Past land use: 1 if implemented conservation practice in the past; 0 otherwise	+
participatory	Inclusiveness of the program in terms of participatory nature of the program in the design phase 1 and 0 otherwise	+
changeifm	Change in farm management required (1=difficult, 0=otherwise)	
info	Access to information and support i.e. EPWS extension services: 1 if yes; 0 if otherwise	+

Data for this chapter were collected through household surveys from 233 household heads, which included 116 program participants and 117 non-

participants. These households were selected from a stratified random sample generated through a participatory wealth ranking exercise (see section 3.2.5). In addition to household surveys, qualitative methods were used to further explore the determinants of a farmer's decision to participate in the EPWS program. These tasks were performed for triangulation and explanation of the determinants of program participation. For this purpose, data were collected from focus group discussions and semi-structured key informant interviews. Focus group discussions included 8 program participants and 8 non-participants while semi-structured key informant interviews included 3 EPWS program staff, 4 village leaders, 8 representatives from EPWS groups in each program village and 8 EPWS participating and 8 non-participating household heads. Data from focus group discussions and semi-structured key informant interviews were manually coded and grouped to generate themes and relevant quotes to support themes and quantitative data (Neuendorf, 2002).

4.4 Results

Respondents included 65% males and 35% females and their average age was 48 years. Almost 70% of the respondents had 7 or more years of education while the remaining 30% had not completed primary school. The wealth ranking exercise identified 55.4% of respondents as middle income, 31.3% as poor and 13.3% as rich. Males made up 80% of the rich, 62.8% of the middle income, and 63% of the poor. The respondents' average harvest included 197kg of maize, 111kg of beans, 50kg of groundnuts, 74 boxes of bananas and 45 boxes of cassava. Irrigation was practiced by 41.6% of farmers: of them, 74% used traditional furrow, 22.7% used buckets and 3.1% used a combination of the two.

The main occupation of nearly all respondents (95.7%) was farming, the rest were self-employed (3%) or wage employees (1.3%). The most commonly grown crops included cardamom, rice, maize, beans, groundnuts, cinnamon, sugarcane, bananas, cassava, sweet potatoes, tomatoes, cabbages, and pineapple. The average farm size was 3 acres: the largest among the respondents was 6.5 acres and the smallest less than an acre. Over half of the households (54.1%) owned private land, 42% cultivated lineage land and 3.9% rented or shared crop lands. Most farms (65.3%) were on moderately hilly or flat terrain, 20% were on hilly terrain and 14.7% were on flat terrain. Most farms had dark brown silt soils locally known as *fifisi* (85.2%) and the rest had either red soil (12.1%), clay soil - *kikododo* (1.3%) or grey soil - *fibwefibwe* (1.3%). Over three quarters (78.1%) of the farmers used soil quality to determine land use, while the rest (21.9%) did so on the basis of road access. The farmers' average walking time from their cultivation to the nearest service road was 60 minutes.

Two thirds (66.2%) of the farmers were aware of the availability of extension services in their villages and 55.1% had received assistance from them. Over half (56.1%) of the farmers indicated that the availability of extension officers had improved a little or a lot with the EPWS, while for 38.8% it had remained the same. Conservation practices had also become more common after the EPWS. Over half (52.2%) of the farmers had planted trees on their farms before EPWS, while after its implementation 75.4% had planted trees. Agro-forestry practices spread from 46.7% of farmers before EPWS to 53.3% afterwards. In addition, after EPWS 37.3% constructed bench terraces, 33.5% of the farmers piled soil up (*fanya juu*) and 42.5% reforested.

The characteristics of the EPWS program participants and non-participants are summarised in Table 4.2. The heads of EPWS participating households were younger than those of non-participating households. They also had received more education than the non-participating heads of households. The EPWS participating households were also larger, with more members contributing to farm work. Finally, the EPWS participating households had larger farms and more sources of income.

Table 4.2. Descriptive statistics for the characteristics of participants and non-participants

Name of the Variable	(1) Participating (n=116)	(2) Not-Participating (n=117)	(3) Differences in mean (1)-(2) t-statistics in parenthesis
Male headed households (%)	72 (0.45)	58 (0.50)	14.3(2.3) *
Average age of the household head (years)	43.72 (13.26)	51.72 (15.89)	-7.99 (-4.17)**
Years of schooling of the household head (mean)	6.49 (1.61)	5.55 (2.06)	0.94(3.9) **
Household members aged 15-64 (mean)	3 (0.93)	2 (1.17)	1 (3.7)**
Number of household members (mean)	5 (2)	4 (2)	1 (3.8)**
Acres of land owned by household (mean)	3.55 (1.44)	2.46 (1.27)	1.08 (6.12)**
Farmers with private land ownership (%)	61 (0.49)	49 (0.50)	12(1.9)
Number of household memberships	3.9 (2.84)	2.0 (2.44)	1.9(5.3)**
Farmers with conservation experience before EPWS scheme (%)	54 (0.50)	38 (0.49)	16 (2.4)*
Inclusiveness of the program in terms of participatory nature of the program in the design phase (%)	53 (0.50)	56 (0.50)	-3 (-0.3)
Change in farm management in EPWS (%)	58 (0.49)	14 (0.35)	44(7.9)**
Access to information and support (%)	84 (0.37)	24 (0.43)	60(11.3)**

Notes. Total sample size = 233 respondents. Standard deviations are in brackets for columns (1) and (2). Column (3) shows differences in mean between participants (1) and non participants (2) as t-statistics in brackets where single, and double asterisks (*) indicate that the means of the groups significantly differ from each other at the 5%, and 1% levels of probability, respectively.

The characteristics of the EPWS program participants are summarized in Table 4.3. The table presents the similarities and differences of the program participants according to low wealth groups (poorer=1, poor=2) and high wealth

groups (rich=3 and richer=4). The poorer are older than the richer. Also, the poorer have significantly less land and working labour available to them. Although differences in educational levels are minimal amongst the wealth groups, high wealth groups have more years of schooling on average than the low wealth groups. Access to information and technical assistance appears to be lower in the low wealth groups than in high wealth groups.

Table 4.3. Characteristics of the EPWS program participants according to asset wealth groups

Name of the Variable	Low wealth assets group		High wealth assets group	
	1(poorer)	2	3	4(richer)
Distribution of participating households (%)	13(11.2)	29(25.0)	32(27.6)	42(36.2)
Number of male household head (%)	9(10.7)	20(23.8)	24(28.6)	31(36.9)
Number of female household head (%)	4(12.5)	9(28.1)	8(25.0)	11(34.4)
Mean age of the household head (s.dev.)	49.8(14.9)	41.5(12.5)	41.3(10.4)	45.3(14.7)
Average number of years of schooling of the household head/respondent (s.dev.)	6(2.4)	6(1.6)	7(1.3)	7(1.5)
Average number of household members aged 15-64 (s.dev.)	2 (1)	3 (1)	3(1)	3(1)
Average number of acres of land owned by household (s.dev.)	1.6(0.48)	2.4(0.66)	4(1.04)	4.6(1.07)
Proportion of households with private land ownership (%)	7(9.9)	19(26.8)	18(25.4)	27(38.0)
Average number of household memberships (s.dev)	1.5(1.6)	3.8(2.6)	4(3.2)	4.5(2.6)
Conservation experience before EPWS scheme (% of Yes)	10(15.9)	14(22.2)	9(14.3)	30(47.6)
Inclusiveness of the program in terms of participatory nature of the program in the design phase (% of Yes)	7(11.3)	12(19.4)	19(30.6)	24(38.7)
Change in farm management required (% of Yes)	5(7.5)	19(28.4)	16(23.9)	27(40.3)
Access to information and support (% of Yes)	11(11.30)	23(23.7)	24(24.2)	39(40.2)

Figure 4:1 displays the proportion of the EPWS program participants who implemented various SLM practices according to the wealth groups. Examination of the presented SLM practices indicates that poor households participate in the EPWS program and that they account for a substantial share of the practices. However, the proportion of the richer with terraces, grass strips, trash lines,

afforestation, contour bunds, riparian reforestation and agro-forestry is higher than that of other households. The high proportion of the poorer and poor with terraces suggests that poorer and poor households are not limited to adopting technically simpler and less difficult practices.

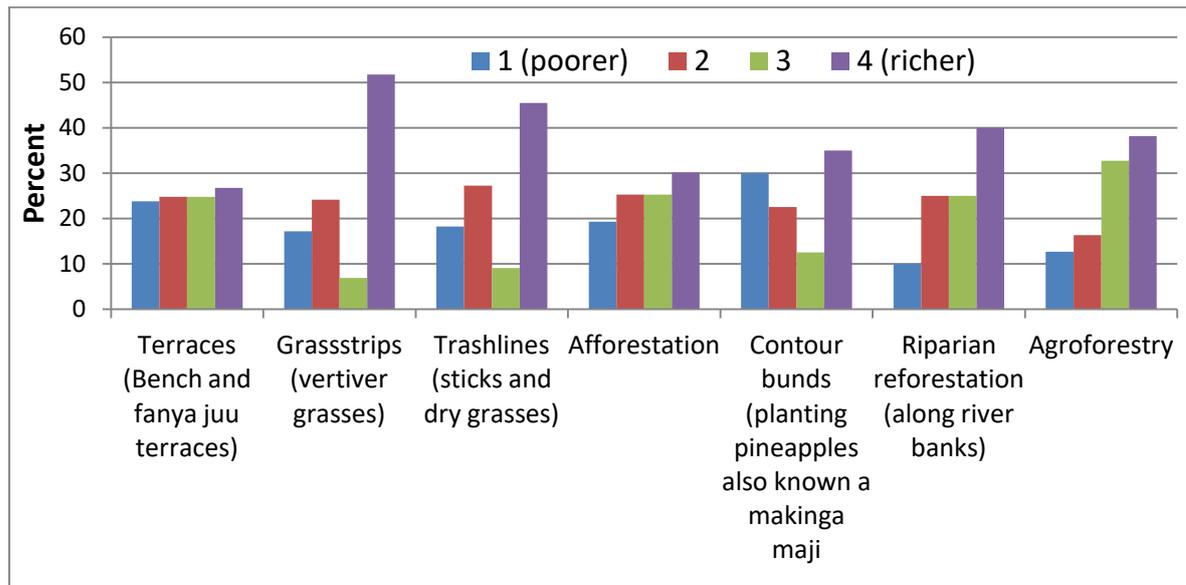


Figure 4.1. The implementation of SLM practices according to the wealth groups of EPWS participants. A household can take part in more than one SLM practices.

To investigate the factors that determine participation decisions in the EPWS program, an econometric analysis of participation was performed. The determinants of participation are reported in Table 4.4. The size of farm, access to information (EPWS extension officer), participatory nature of the program in the design phase, and the magnitude of required changes in farm management are all positive and significant determinants of farmer participation in the EPWS program. Other positive variables, which are not significant, include education of the head of household, household head's social affiliations, household labour, past conservation experience and type of land ownership. Variables that were negative but not significant determinants of participation in the EPWS program

include gender of the household head, the importance of non-timber forest products and the age of household head.

Table 4.4. The logistic regression results for the determinants of participation in the EPWS program

Variable	Estimated Coefficients	S.E	t-Ratio	Marginal effects	Odds ratio
Gender of the household head	-0.15	0.52	-0.29	0.78	0.86
Age of the household head	-0.02	0.02	-1.00	0.30	0.98
Years of schooling of the household head	0.01	0.12	0.08	0.96	1.01
Household members aged 15-64	0.15	0.2	0.75	0.45	1.16
Acres of land owned by household	0.38	0.17	2.24*	0.03	1.46
Land ownership type	0.33	0.48	0.69	0.49	1.39
Number of household memberships	0.05	0.16	0.31	0.75	1.05
Conservation experience before EPWS scheme	0.48	0.42	1.14	0.26	1.61
Inclusiveness of the program in terms of participatory nature of the program in the design phase	0.12	0.48	0.25	0.80	0.89
Change in farm management	1.76	0.46	1.65*	0.10	2.14
Access to information and support	1.45	0.48	3.02**	0.03	4.28
Constant	-3.82	1.43	-2.67*	0.01	0.02
Nagelkerke R ²					0.67
Likelihood Ratio Test X ²					13.955 (8df)
Hosmer and Lemeshow Test					0.83
Proportion of observation correctly predicted as participants %					86.2
Proportion of observations correctly predicted as non-participants %					80.3
Overall percentage correctly classified (%)					83.3
Total number of observations					233
*Significant at = 0.05%.					
**Significant at = 0.01%.					

Farm size is a positive and significant determinant of farmer participation in the EPWS program (Table 4.4). Key informant interviews and focus group discussions confirmed that farmers who have large land holdings adopt SLM practices such as terraces and agro-forestry more than small land holders. Moreover, they are considered to be more flexible, wealthier and able to handle risk of crop failure by dividing up farms for use for different purposes unlike smaller land holding farmers. The concern of most of the non-participants was that the construction of terraces leaves the soil infertile and unproductive as the

fertile top soil is buried beneath unfertile rocky soil. A farmer stated in an interview that, *“if I construct terraces ... my children will die of food shortage; as without manure I will not be able to harvest anything”* (male farmer, program non-participant, Lanzi village – interview statement, 2011).

Farmers' access to information is another positive and significant determinant of farmer participation in the EPWS program (Table 4.4). Focus group discussions illustrated that the public meetings conducted by the EPWS officers in each program village provided information that was used to make participation decisions. Information about the EPWS program was also disseminated by the CARE staff stationed in program villages to provide technical assistance. Information was also spread and obtained from farmer to farmer interactions: information on experienced harvest improvements was often obtained from neighbours and it was considered an important reason for adopting the SLM practices of the EPWS program. For example, a farmer explained that *“I did not join the EPWS program from the beginning because I did not believe what the EPWS experts were telling us; but when I witnessed what my brother was harvesting from his small terraced farm, I was convinced that constructing terraces was a deal. I immediately hired terrace construction experts and asked the CARE experts to provide advice to construct terraces in my three acre farm”* (male farmer, program participant, Lanzi village – interview statement, 2011).

Information was also received by farmers during local training workshops. Workshops aimed to create awareness and develop practical skills amongst farmers for adopting and implementing project measures. According to the EPWS

program officer, nearly 700 farmers were trained between July 2009 and June 2010 on sustainable land management practices, including the construction and use of “*fanya juu*” and bench terraces, tree nursery establishment and management, tree planting methods and field management, grass strip farming techniques, practices to improve soil moisture and production, and animal husbandry for income generation and manure production.

The participation of farmers in the design phase of the EPWS program is a positive determinant of participation (Table 4.4). Key informant interviews and focus group discussions suggest that the design phase involved consultative (functional) participation in the context of research and village meetings in which the EPWS programs’ SLM practices were marketed to farmers. However, the consultation did not determine programme content. As a result of this, one farmer stated that *“if the program was collaborative and our opinions were sought and considered in the design of the program, we would prefer to start the EPWS program by keeping livestock for manure, followed by construction of bench terraces and fanya juu”* (male farmer, program participant, Nyingwa village – interview statement, 2011). However, the response to this was that, *“while the participation of farmers in the design phase was not high, their ideas and needs have been incorporated in the program implementation as they arise, although not all of their needs are taken in the program given the resource limitations”* (EPWS program officer – interview statement, 2011).

Another positive and significant determinant of farmer participation in the EPWS program is the magnitude of required change in farm management (Table 4.4).

Key informant interviews and focus group discussions highlighted that the adoption of agro-forestry measures and reforestation was easier than the construction of bench terraces and *“fanya juu”*. The main constraint for the adoption of terraces is the high cost of labour needed for their construction and a lack of manure that would reduce harvests, as newly constructed terraces can take up to four years to regain fertility. Nevertheless, in the focus group discussions and key informant interviews, it was explained that, through membership of farmer groups established through the EPWS program, work collaborations were established in which the program participants agree to help one another in implementing SLM practices such as the construction of terraces, which need more labour. A key informant explained that *“membership in the farmer groups is the most important mechanism which has increased our ability to work together particularly in the construction of terraces through labour exchanges”* (female farmer group leader – interview statement, 2011). In addition, a farmer explained that *“the construction of these terraces was possible because of the help I received from my fellow farmer group members as we rotate from one member to another to encourage one another and aggregate weak individual power to many which means more power”* (female farmer, program participant, Nyingwa village – interview statement, 2011).

The temporary crop yield decline was considered to endanger food security. A farmer stated that *“we have shortage of food now because our harvests were very little due to the lack of manure”* (female farmer, program participant, Dimilo village – interview statement, 2011). Also, it was stated that *“most people don’t have land beyond two acres, so if we plant many trees and construct terraces*

which take years to bear fruit, then staple food production will be affected" (village leader, Dimilo village – interview statement, 2011). In addition, construction of terraces, and adoption of agro-forestry or reforestation is limited by customary land tenure systems which do not allow construction of permanent structures on customarily owned land.

4.5 Discussion

The findings of this study extend the limited empirical evidence relating to the investigation of poor household participation in agro-ecosystem PES programs and factors that affect farmers' decision to participate in these programs in developing countries. The analysis of the findings demonstrates that eligible poor households participate in the EPWS program and their participation in different LSM practices is relatively low in some practices compared to relatively rich households but neither shut out nor restricted to the simpler and cheaper forms of SLM practices. The factors that affect program participation are farm size, access to information, landholder participation in the program design and the magnitude of change in farm management required by the program. Many of the determinants are consistent with the factors in other studies that have investigated participation or adoption of agricultural conservation technologies.

Firstly, farm size is often reported to influence the adoption of soil and water conservation measures such as bench terraces, "*fanya juu*" and stone terraces (Santos et al., 2006). The common explanation for this finding is that larger farms can offer farmers more flexibility in decision making, greater access to discretionary resources, and more ability to deal with risks and more opportunity

to try new practices than it is possible for farmers with small farms (Amsalu and De Graaff, 2007). Farmers with large farms often invest more in conservation measures to increase farm income and wealth than those with small farms (Woldeamlak, 2007). Farmers with small farms lag behind in the adoption of terraces. In Ethiopia, Amsalu and De Graaff (2007) reported that the loss of land fertility due to terracing and temporal decline of yields discouraged small farmers from adopting stone terraces. Tenge et al. (2005) reported a similar finding from the West Usambara Mountains – the adoption of major soil and water conservation measures was lower among farmers with small farms than among farmers with larger land.

Secondly, access to information significantly influenced participation decisions in the EPWS program. This is not surprising because previous studies have long recognized the importance of information availability and access in the adoption and diffusion of innovation (Knowler and Bradshaw, 2007). It has been shown that information about conservation programs helps the farmer to confirm or dismiss their positive or negative views or prior expectations about a programme (Frondelet et al. 2012). Indeed, information is crucial for land owners before they can make decisions about opting in or opting out of agricultural conservation program. This shows that channels or sources of information such as other farmers, media, meetings and extension officers need to be considered and improved to ensure the success of conservation practices (Knowler and Bradshaw, 2007). The choice of information channel is crucial because some channels can be significantly limited by the ability of potential adopters to access the available information and understand the message communicated to them

(Napier, 1991). Some channels are more effective than others. In this study, farmer to farmer communication was important in influencing adoption of sustainable land management practices such as bench terraces, "*fanya juu*", agro-forestry and high value crops. This suggests that positive farmer-to-farmer communication has the potential to increase adoption of programme practices even after the program ends.

Thirdly, the study findings show that farmers are more willing to participate when the program is participatory. In the case of the EPWS program, participation levels could have been higher, if the views of the farmers on the importance of the availability of manure had been heeded in the design of the programme. As several other studies have reported, using a participatory approach in the implementation of conservation projects is invaluable. For example, in a case study on the Peruvian Andes, Posthumus (2005) shows that a participatory conservation programme has a significant positive influence on the adoption decision compared to a top-down conservation programme. Pretty and Shah (1997) similarly report that the use of a participatory approach encourages an amalgamation of farmers' knowledge with scientific knowledge while strengthening local capacities to experiment and innovate. In general, a participatory approach is a necessary precondition for effective implementation of sustainable land management practices.

Fourthly, we find that the magnitude of change in farm management required by the programme significantly influenced farmer participation in the EPWS program. It has previously been reported that conservation technologies, which

are easy to adopt for a particular farming system are more likely to be adopted than the difficult ones (Napier, 1991). It has also been reported that farmers are less likely to participate when a program requires substantial changes in farm management (Wilson and Hart, 2001). Similar findings have been reported by Shiferaw and Holden (2000) in Ethiopia, Lapar and Pandey (1999) in the Philippines and Kerr and Sanghi (1992) in India. Lack of resources and high labour demand often constrain conservation practices such as construction of terraces and agro-forestry (Napier, 1991).

Fifthly, the findings suggest that the acceptance of terraces in the EPWS program with PES incentives is novel. Construction of terraces introduced without incentives by the Uluguru Land Usage Scheme was violently resisted in the case study area in the 1950s (Carswell, 2006; Young and Fosbrooke, 1960). A PES approach has potential to encourage the adoption of agricultural pro-environmental behaviours such as construction of terraces and other conservation measures. However, customary land tenure poses a considerable challenge to agricultural land based PES programs in Morogoro and elsewhere in Tanzania because it restricts the right to create permanent structures and improvements on clan land. That is, the adoption of sustainable land management practices on the basis of PES incentives may not be compatible with the customary land tenure rules.

Finally, although one of the main intentions of EPWS programs is to achieve equity, the findings show that farmers who have more land are more likely to participate than those with less land. This is not surprising because the payments

made under PES programs are payments to farmers for undertaking land use changes required by the program (Wunder, 2008b). Land ownership and distribution are critical to whether the programme can achieve its poverty reduction and equity objectives (Wunder, 2008b). The size of land holdings will influence farmers' decision to participate in agricultural land based PES programs. This will be a critical factor for targeting of PES contracts: targeting them to fewer farmers with big farms makes more economic sense than targeting many small farms. This could make a PES program efficient while reducing administrative costs. The implication of this is that equity goals may conflict with the efficiency and environmental goals of a PES program. As such, this will in turn force policymakers to choose an optimal balance among multiple goals.

4.6 Conclusion

In this chapter, the findings demonstrate that farm size, access to information, participation of farmers in the design phase and the change in farm management required by the program significantly influence the decisions to participate in the EPWS program. Given the widespread problem of watershed degradation in developing countries, these findings point to the urgent need for the establishment of PES programs on agricultural lands to maintain and improve the quality and quantity of water resources in developing countries.

The most important findings are that poor households who are landholders are able to participate in the EPWS program and are implementing practices such as construction of terraces and agro forestry. Also, farmer groups formed in association with the EPWS program have encouraged more work collaborations

among members thus facilitating construction of terraces. Ideally, the formation of farmer groups along with the implementation of SLM practices through PES is vital to facilitate work collaborations in a more effective way.

Furthermore, the study suggests that the effective design and implementation of PES programs in agricultural systems require a thorough understanding of resource manager characteristics, features of the PES program and the institutional context within which the PES program is implemented. This is vital to enhance the participation of poor farmers who may not be able to participate unless necessary measures are taken to enable their participation. These can be very context specific such as when the supply of manure is a key obstacle preventing construction of terraces on land needed for continuous food production. This would require rigorous assessment of farmers' preferences from the local perspective during the design of PES programs. Also, full participation of farmers /land managers in both program design and implementation could ensure that factors crucial for participation of more disadvantaged farmers do not become unnecessarily compromised.

Chapter 5: The Livelihood Outcomes of the EPWS Programme

5.1 Chapter Outline

In fulfilment of objective two of this thesis, this chapter investigated the direct and indirect financial and non financial livelihood outcomes of the EPWS program. To achieve this objective, a quasi-experimental mixed methods research design with propensity score matching was used. Propensity score matching technique was used to establish counterfactual effects of the program in terms of examining what would have happened to the program participants, if they had not participated in the program. Result shows that program participants, including women and the poor, have not been made worse in terms of the impact of the program on their indirect financial and non-financial livelihoods including household's average number of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program. The results clearly indicate the potential of PES schemes to generate win-win outcomes in agro-ecosystems, but they also call for attention to equity in the design of PES programs implemented on agro-ecosystems. All chapter results are presented in section 5.4 comprising both direct and indirect financial and non-financial livelihood impacts of the EPWS program as well as gender and wealth distribution of outcomes. Section 5.5 presents the discussion of the findings and section 5.6 provides the chapter conclusions.

5.2 Introduction

Primarily, PES programs are designed to enhance the supply of ecosystem services. However, in developing countries, there is also a considerable interest

to achieve poverty alleviation objectives (Pagiola et al., 2005; Wunder, 2008b; Zilberman et al., 2008). According to Ferraro (2009b), poverty alleviation and equitable wealth distribution are important components of the existing and planned PES programs in sub-Saharan Africa. For example, in the South African Working for Water program, poverty alleviation and provision of services are treated equally as joint products or co-benefits (Turpie et al., 2008; Ferraro, 2009b). In Tanzania, the EPWS program has considerable emphasis on fair and equitable distribution of benefits accruing from the sale of ecosystem services to downstream users (Lopa et al., 2012).

PES programs can affect livelihoods both directly and indirectly, and financially and non-financially. The most obvious impact is through a direct financial payment to program participants for adopting specified land use practices (Pagiola et al., 2005; Molnar et al., 2008). PES programs can also increase land tenure security (Grieg-Gran et al., 2005) and the value of marginal land owned by poor farmers who may find it attractive to plant trees because of their lands' low opportunity cost (Pagiola et al., 2005).

PES programs can also affect disadvantaged farmers by providing training and technical support (Tacconi et al., 2010), increasing labour demand and the availability of and access to natural resources (e.g. non-timber products) (Pagiola et al., 2005; Tacconi et al., 2010), as well as by affecting social and cultural aspects of a community (e.g. social networks) (Caplow et al., 2011). PES programs can also change internal and external relationships and institutions (Grieg-Gran et al., 2005; Pagiola et al., 2005).

PES programs can also impact indirectly on the livelihood of non-participants, such as those depending on agricultural employment, non-timber forest products such as fodder, medicinal plants and fuel wood and hire of idle land (Pagiola et al., 2005). Employment impacts will depend on the difference in labour demand between the land use promoted by a PES program and the prevailing land uses (Engel et al., 2008; Zilberman et al., 2008). Land use restricting PES programs can have negative impacts on employment while land modifying programs may have positive impacts (Engel et al., 2008), depending on the extent of change in local labour demand and the existence of other sources of employment (Zilberman et al., 2008). For example, the Costa Rican PSA program mostly seeks to conserve forests, which is not labour intensive (Pagiola and Platais, 2007).

A PES program can affect the livelihoods of the poor farmers through the promoted land use changes which can alter the availability and access to goods such as non-timber products (Kerr, 2002). When implemented on private lands, a PES program can only affect access to non-timber products depending on the previous status of the land in terms of access (Landell-Mills and Porras, 2002; Pagiola et al., 2005). The implementation of a PES program on community land is of particular concern because these lands are often used by disadvantaged people for the collection of non-timber products such as fodder, fuel wood and other products (Kerr, 2002). In addition, while the enrolment of community land may limit collection of products such as non-timber products, the resulting payments may not necessarily be distributed in the same proportions as the lost benefits by the poor (Alix et al., 2003; Pagiola et al., 2005).

Other indirect effects of a PES program on livelihoods may include an increase in food prices if a program results in the reduction of agricultural production as a result of switching land from agriculture to forestry (Pagiola et al., 2005). This would however depend on the size and productivity of enrolled land because enrolment of the most productive agricultural land may mean enrolment of land with high opportunity costs and with consequences on food availability and access. However, depending on the size and productivity of enrolled land, if a PES program promotes sustainable land use for agriculture, the pressure on food prices are likely to be reduced (Tacconi et al., 2010). PES programs can also affect the livelihoods of the poor when they curtail availability of and access to land in the context of insecure land tenure (Landell-Mills and Porras, 2002). In particular, this could happen, if, by increasing the value of marginal land, it increases the incentives for powerful groups to take control of land or when powerful NGOs and external institutions block future aspirations of land managers to develop their land (Landell-Mills and Porras, 2002).

The livelihood impacts of PES programs on the upstream participants and non-participants have been examined in several studies (Landell-Mills and Porras, 2002; Miranda et al., 2003; Grieg-Gran et al., 2005; Pagiola et al., 2005; Neef and Thomas, 2009; Cole, 2010; Tacconi et al., 2010; Tacconi et al., 2011). In these studies, the sustainable livelihood approach has been used to examine livelihood impacts. This has broadened impact evaluation from a narrow consideration of income contribution to a wider appreciation of how programs interact with a wider set of livelihood assets (natural, human, financial, social and

physical), activities and entitlements (Chambers and Conway, 1992; Scoones, 1998; Ellis and Freeman, 2005) that are dynamic and subject to continuous management and modification (Scoones, 1998; Ellis and Freeman, 2005; Sallu et al., 2010).

While there are studies that have investigated livelihood impacts of PES programs, the majority of these are on use-diverting forestry programs (i.e. forest conservation, including REDD, biodiversity, water) (Landell-Mills and Porras, 2002; FAO, 2007b; Porras et al., 2008; Wunder et al., 2008; Ribaud et al., 2010; Wunder and Börner, 2011a; Schomers and Matzdorf, 2013) rather than on use-modifying programs. In addition, the majority of these studies lack a rigorous impact evaluation framework (Ferraro and Pattanayak, 2006; Pattanayak et al., 2010). Often, the non-random nature of program design and implementation makes it difficult to disentangle the effects of a program (i.e. conservation impacts such as the change in land use) from the effects of other policy measures and broader economic trends when evaluating their impacts (Ferraro and Simpson., 2002; Ferraro and Pattanayak, 2006; Wunder, 2007; Margoluis et al., 2009; Djamhuri, 2012). Due to this, the aim of this chapter is to employ a rigorous cause - effect impact evaluation approach to evaluate the livelihood impacts of an agro-ecosystem based PES program using the EPWS program as a case study. This study is vital because the interest in implementing PES on agro-ecosystems in developing countries to achieve poverty reduction and supply of ecosystem services is considerable, but they are as yet largely unstudied (FAO, 2007b; Ferraro, 2009b; Schomers and Matzdorf, 2013).

5.3 Material and Methods

For this chapter a mixed method quasi-experimental research design with propensity score matching (described in chapter 3) was used to examine the direct and indirect financial and non-financial livelihood impacts of the EPWS program as well as its distribution of outcomes. A household survey questionnaire, which combined both closed and open ended questions was used to collect data on the livelihood assets of EPWS program participants and non-participants. The questionnaires were administered to 233 household heads comprising 116 program participants and 117 non-participants. These households were selected from a stratified random sample generated through a participatory wealth ranking exercise (see section 3.3.5).

The questionnaire covered the potential outcomes of the EPWS program in terms of changes in human asset variables (i.e. the amount of training attended by members of a household), social asset variables (i.e. the number of memberships and affiliations of trust), and financial asset variables (i.e. the number of livestock and crop harvests, non-agricultural salaries and remittances). In addition to a household questionnaire, focus group discussions and key informant interviews were conducted for triangulation purposes. Focus group discussions were performed with 8 groups of program participants and 8 groups of non-participants while semi-structured key informant interviews were undertaken with 3 EPWS program staff, 4 village leaders, 8 representatives from EPWS groups in each program village and 8 EPWS participating and 8 non-participating household heads. Key informant interviews conducted with the

EPWS program officer were used to collect data on the program participants and amounts of payments.

After matching treatment group with control group, a simple difference approach (Baker, 2000; White, 2006) was applied to estimate the impact of the EPWS program on the livelihoods of program participants. The impacts were analyzed using independent t-test for parametric data and Kruskal Wallis Test and Mann-Whitney U test for non-parametric data performed on SPSS for windows. Qualitative data from focus group discussions, key informant interviews and participant observations were manually coded (Neuendorf, 2002) and relevant quotes were extracted to support themes and quantitative data.

5.4 Results

5.4.1 Direct and Indirect Financial and Non-financial Benefits

5.4.1.1 Direct and Indirect Financial Benefits

The direct benefit that the EPWS program participants receive is cash payments for the adoption of SLM practices. The EPWS program's key informant explained that the average payment received by the program participants was US\$11 (ranging between US\$8-US\$48). This was paid to the first group of program participants in 2011. In addition to cash payments, the findings show significant positive changes in the average annual cash income ($P < 0.01$) amongst the program participants, whereby income from the sales of crops was significantly higher for program participants when compared to non-participating households (Table 5.1 and Figure 5.1). There was no significant difference in average annual expenditure and in the number of sources of household cash income for the program participants when compared to non-participants.

Table 5.1. Average household income and number of income sources of EPWS program participants (116) and non-participants (116) in 2011

		Mean	Std. Deviation	Std. Error Mean	t-Test	Mean Difference	Std. Error Difference
Average annual cash income (TSh)	1	100,655	76,551	7,107	1.69*	16,689	9,869
	0	83,966	73,747	6,847			
Average annual expenditure (TSh)	1	473,683	308,036	28,600	1.52	61,006	40,033
	0	412,677	301,699	28,012			
Sources of income	1	1.98	0.71	0.07	1.50	0.14	0.09
	0	1.84	0.69	0.06			

Note: 1 = Program participants and 0= Non-participants. Analysis refers to statistical independent samples t-test for differences in means **P<0.01, *P<0.05. Sources of income include sales of crops, sales of livestock, sales of vegetables, business income, wage/salaries, cash remittances and other casual cash earnings.

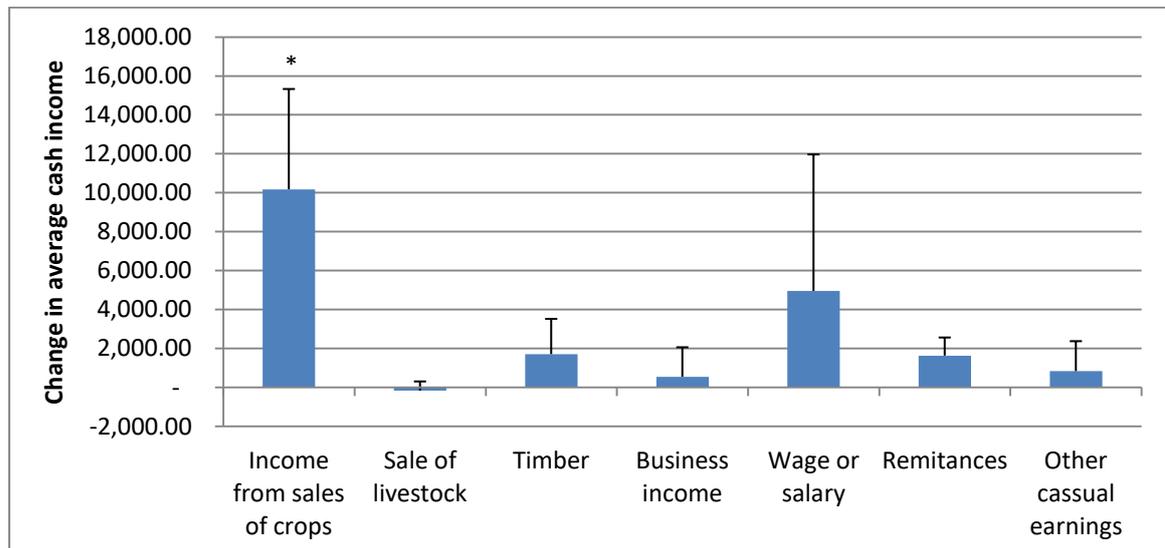


Figure 5.1. Average household cash income by sources for program participating households when compared to non-participating households.

Analysis refers to statistical independent samples t-test for differences in means **P<0.01, *P<0.05.

The EPWS payments contributed to about 20% of a program participating household's average annual cash income (Table 5.1). These payments are, therefore considered as an important source of households' cash income. A key informant for example explained that: *"the payment I received is a large amount of cash that I can get at once"* (female farmer, program participant, Lanzi village – interview statement, 2011). Another key informant explained that: *"the money I*

received helped me to buy two chickens which are my important source of meat and quick source of money to solve urgent problems such as attending to sickness or children's school needs" (male farmer, program participant, Nyingwa village – interview statement, 2011). During group discussions with project participants, it was explained that the EPWS payments had been used to improve houses, purchase food, livestock (e.g. chicken and goat for milk and manure), clothes, radios, furniture, to pay school fees and to purchase better seeds.

The findings also show that participating in EPWS program improves cash income from crop yields, wage or salary, timber and business income. The crops that had significant increase amongst the program participants, were beans ($P<0.05$), tomatoes ($P<0.05$), and cabbage ($P<0.01$) (Figure 5.2). With regard to the positive change in yields (Figure 5.2), key informants and FGD participants explained that the yields had increased because of the introduction of improved agricultural practices such as ploughing, intercropping of maize with cover crops such as beans and groundnuts, agro-forestry (i.e. bananas and trees), use of improved seeds and application of animal manure. Yields also increased due to specialization in high value crops such as beans, bananas, tomatoes and cabbage (for cabbage see Figure 5.4). Household interviews also show that 69% of participants and 21% of non-participants have established and used compost manure in their gardens.

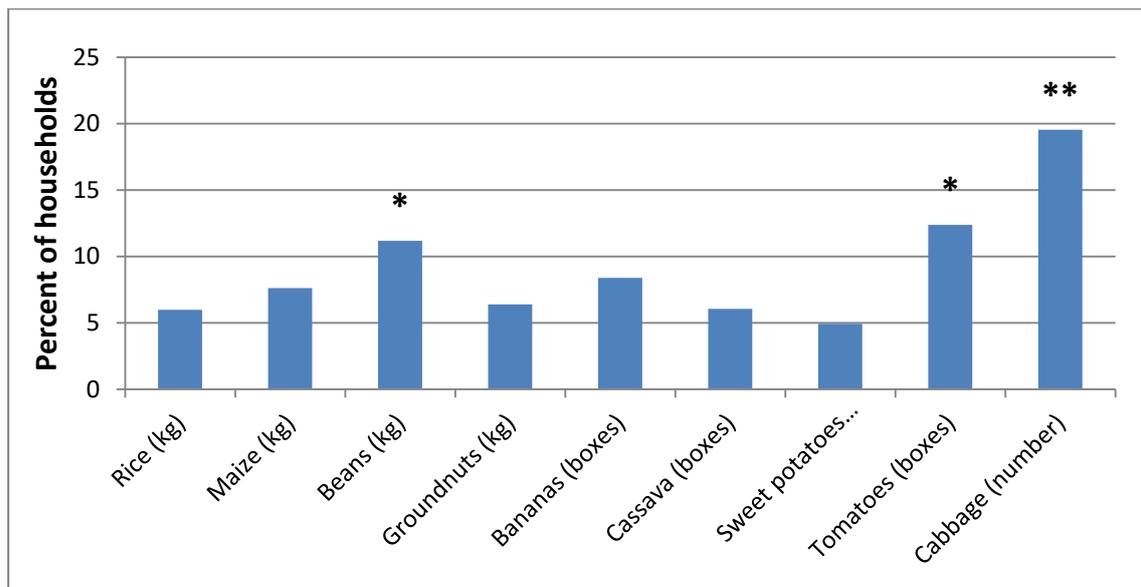


Figure 5.2. Outcome of EPWS program on average crop yields among the program participants compared to non-participants in 2011 (difference = participants outcomes – non-participants outcomes).

Note: 1: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. ** $P < 0.01$, * $P < 0.05$.

The average amount of livestock amongst the program participants is also high compared to non-participants. The program participants have, on average, more chickens ($P < 0.01$) and goats ($P < 0.05$) than non-participants (Figure 5.3). Key informants and focus group participants explained that the participants have been taught and encouraged to construct livestock sheds (see Figure 5.5). By 2011, 35 livestock sheds had been constructed and most of the program participants had moved their goats from the forest to constructed sheds. In addition, some program participants have purchased goats, pigs and chickens using received PES payments.

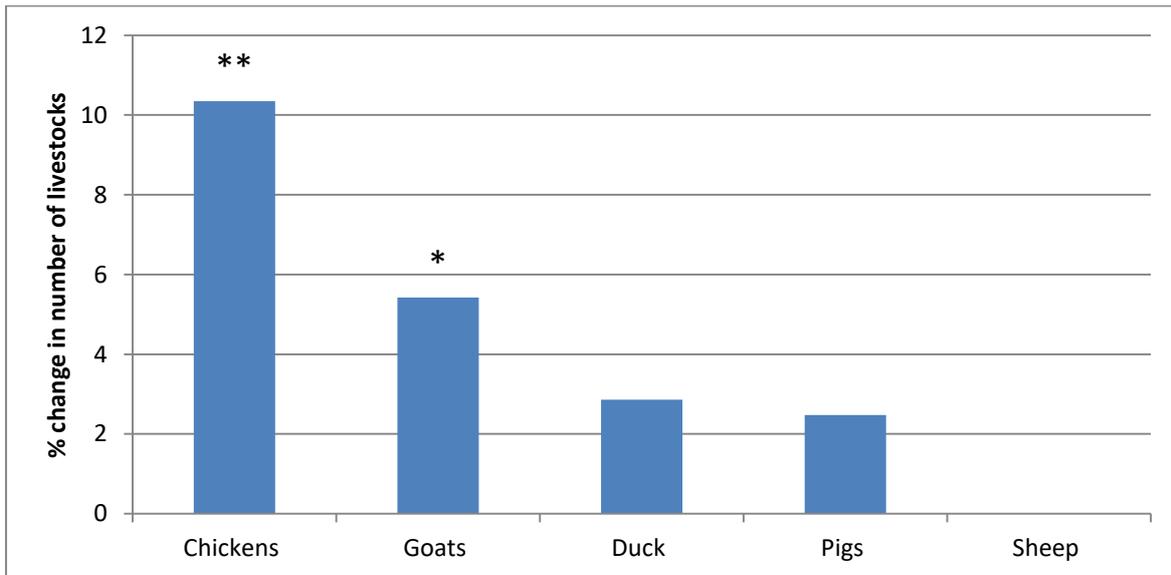


Figure 5.3. Outcome of the EPWS program in livestock keeping amongst program participants (difference = participants outcomes – non-participants outcomes).

Note: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. ** $P < 0.01$, * $P < 0.05$.



Figure 5.4. Cabbage farm in Lanzi village



Figure 5.5. Newly constructed goat shed in Kibungo village

Key informants and participants in group discussions also explained that, in addition to the EPWS program payments, there are people who have increased their cash income from daily and monthly casual and business employment generated by PES activities. Ownership of consumer durables such as machetes ($P < 0.05$), hoes ($P < 0.01$), radios ($P < 0.05$), mobile phone ($P < 0.01$), and spades ($P < 0.01$) is also higher amongst program participants (Figure 5.6).

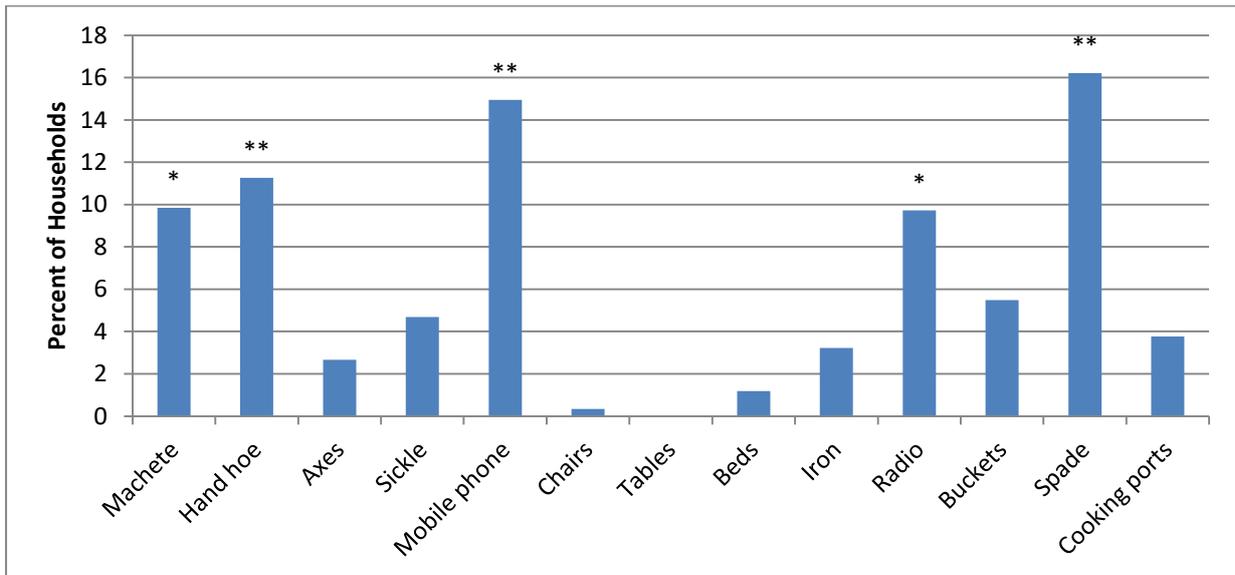


Figure 5.6. EPWS participant's ownership of consumer durables when compared to non-participants (difference = participants outcomes – non-participants outcomes).

Note: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. **P<0.01, *P<0.05.

There are three to five people in each village who are employed to take care of tree nurseries established by CARE Tanzania (see Figure 5.7 and 5.8) as part of EPWS program and they receive an annual salary of about US\$441. In addition, 31.7% of participants and 20.7% of non-participants have one or two household members working casually for cash income as a result of the EPWS program. They work on the construction of terraces and excavation of banana and tree pits for richer households. The average income for a casual labourer is about US\$1.8 per day or US\$25.7 for 14 days of work constructing an acre of terraces or excavating an acre of banana pits.



Figure 5.7. Tree nursery in Kibungo Village (2011)



Figure 5.8. Tree nursery in Lanzi village (2011)

According to interviewed key informants and focus group discussions, the construction of terraces and tree planting has not only contributed to increased productivity of lands, it has also increased the likelihood of a land owner farming more of their land, and has increased the value of arable land involved in the program. A farmer tells that *“....according to our custom, anyone can go to any landholder with idle land and borrow it either without paying or in return for an agreed share of the harvest. The program has now motivated those who used to lease their idle land to plant trees in order to be paid money and as a way of*

generating assets for future sale of trees or timber” (male farmer, program participant, Nyingwa village – interview statement, 2011).

According to the key informant interviews and focus group discussions, the average price of land before the construction of terraces, ranged between US\$74 and US\$216 per acre in hilly terrain and between US\$248 and US\$496 on flat terrain (Village leaders). However, after terracing, the average price of arable land increased to about US\$2,168 per acre in hilly terrain (Village leaders). Whilst very beneficial for the land owner, this reduced availability of land and increase in land value has reduced access to land among the landless and those with small land holdings. Increases in the average rental price of land were noted between 2008 and 2011, shifting from nothing in 2008 to between US\$1.8 and US\$3 per acre per year in 2011 (Village leaders).

The findings also show that EPWS participants have enhanced their ability to meet household food needs more than amongst non-participants. The proportions of participants exchanging labour for food, reducing the number of meals eaten in a day, limiting meal sizes, skipping an entire day without eating, purchasing food on credit and experiencing difficulty satisfying household food needs was lower than amongst non-participants (Figure 5.9).

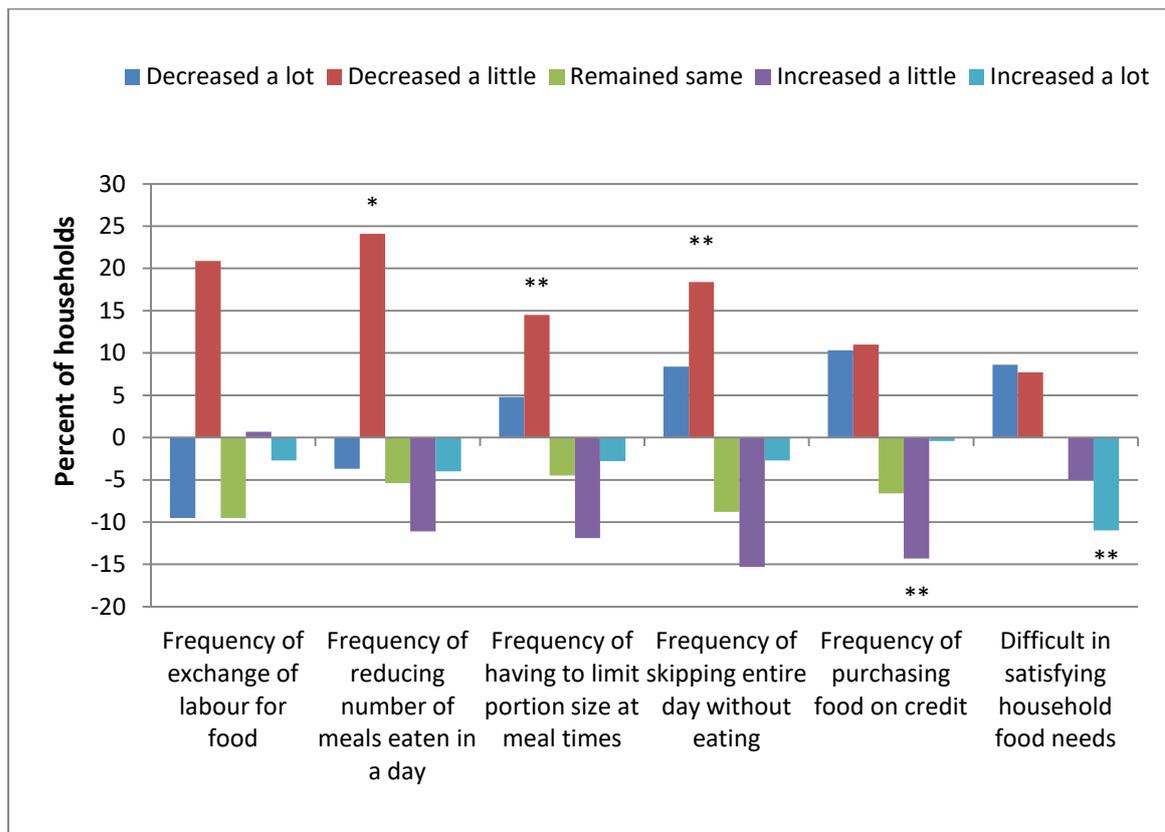


Figure 5.9. Household food needs of EPWS program participants compared to non-participants in 2011

Note: 1: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. **P<0.01, *P<0.05.

5.4.1.2 Indirect Non-financial Outcomes

The EPWS program has also affected livelihoods through indirect non-financial outcomes. These are improved access to information on SLM, established and strengthened institutions within the community, improved reciprocity and trust in the community, and extension of internal and external networks. The participants again benefited more from training (P<0.01) (Table 5.2) and extension services. 86% of participants received assistance from EPWS extension staff and the ward agricultural extension officers compared to 16% of non-participants receiving such support. The availability and access to extension services was higher for program participants, with some but lesser influence on non-participants; 83% of

participants and 27% of non-participants acknowledge an increase while only 15% participants and 67% of non-participants consider their availability and access have remained the same.

Table 5.2. Household members who have received training amongst EPWS program participants and non-participants after 2008

	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Program participants	2.1	2.59	.24	**
Non-participants	.61	1.43	.13	

Note: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. **P<0.01, *P<0.05.

The availability of environmental and agricultural information was higher for program participants. This increase was claimed by 91% of participants and 42% of non-participants while only 10% of participants and 55% of non-participants regard it to have remained the same. The key informants and those in group discussions explained that the increase in the availability of environmental and agricultural capacity, skills and knowledge amongst participants was caused by their interaction with the program extension officers, as well as participation in dissemination workshops and study tours. They also benefited from EPWS program trained (5 - 8 in each village) para-professionals who serve as local extension contacts. Moreover, the key informants and those in group discussions explained that the availability of environmental information was increased by dissemination carried out in four primary schools and one secondary school through environmental education both in theory and in practice. It was explained that “over 10,000 trees have been planted in the program village school and students have taken home trees from the schools managed tree nurseries established through the EPWS program” (EPWS program officer – interview statement, 2011).

The EPWS program has also strengthened and created new institutions, improved relationships of trust in the community and has expanded internal and external networks. For example, in addition to formal EPWS contract requirements, farmer groups have established additional group rules to guide their operation to achieve collective obligations. These new rules enable farmer groups to sanction a defaulter by eviction from the group or by fines. A farmer group member in Nyingwa village explains that: “if a member of our group fails to attend group work for more than two days, s/he will be required to return any group tool and pay a fine of USD12” (female farmer group leader – interview statement, 2011).

The program participants also demonstrate significant positive change in the number of memberships ($P < 0.05$) (Table 5.3). In focus group discussions, it was explained that memberships and interactions through EPWS program works increase the ability of people to work together and that relationships of trust facilitate reciprocal financial assistance. Memberships help to build more work collaborations whereby gathering or participating in the EPWS program meeting provide opportunities for discussions about their work and this often leads to agreements to help each other (e.g. in constructing terraces where more labour is needed). In this context, memberships facilitate exchange of ideas and collaborations. With regard to gender related changes, there is a significant change for males ($P < 0.05$) (Table 5.3). In the focus group discussions, it was explained that the significant positive change for males is associated with household distribution of labour whereby women are engaged in household or

home based activities more than males who are often engaged with external activities which include participating in meetings.

Table 5.3. Household membership in various groups amongst EPWS program participants and non-participants

		Are you involved in the EPWS program?	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Memberships ¹ (number)	male & female	Program participants	3.30	2.59	0.24	**
		Non-participants	2.44	2.36	0.21	
Memberships ¹ (number)	Male	Program participants	2.11	1.96	0.18	**
		Non-participants	1.43	1.61	0.14	
	Female	Program participants	1.18	1.55	0.14	NS
		Non-participants	1.00	1.32	0.12	
Membership in SACCOS (number)	Men	Program participants	0.25	0.51	0.04	*
		Non-participants	0.17	0.37	0.03	
	Female	Program participants	0.25	0.43	0.04	*
		Non-participants	0.18	0.40	0.04	

Note: 1: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. **P<0.01, *P<0.05. ¹Memberships include forest management, religious based organization, committee of school, membership in Savings and Credit Co-operative (SACCOS), Non-Governmental Organisations (NGO), village government and EPWS village group and ward network group.

The relationships of trust amongst the EPWS program participants have changed significantly ($P<0.1$) compared to non-participants (Table 5.3). Trust was defined by FGD participants as the ability and willingness to give and receive assistance from people beyond immediate household (relatives or friends) in case of food and money shortages. With respect to various aspects of relations of trust, the findings show that 67% of participants and 44% of non-participants provide family help to a friend, 58% of participants and 49% of non-participants borrowed money from a friend, and 62% of participants and 40% of non-participants lent money to a friend or relative. FGDs and key informants considered participants' involvement in various EPWS group activities as the main aspect that increased

trust among them, since many were implemented through farmer groups (examples include groups for tree planting, terrace construction groups, high value crop growing and livestock rearing groups). As a result, participants are more connected than non-participants, and the EPWS has contributed to increased trust among participants more than among non-participants.

It was also explained in the focus group discussions that their trust in outsiders has increased as a result of the EPWS program. The villagers had been fearful of outsiders, locally called "*chinja chinja*" translated as 'killers' based on stories of mysterious human deaths and disappearance in the late 1890s and early 1900s during German colonial rule. According to the key informant, this fear had manifested itself in the 1970s as resistance to the Red Cross blood donation program (male farmer, program participant, Nyingwa village – interview statement, 2011). Expanded networks to national and international researchers, CARE and WWF organizations and associated program staff, extension staff, DAWASCO and Coca Cola Kwanza Ltd as well as other external organizations and actors facilitated through the EPWS, were explained as the key contributing factors for increased trust in outsiders. It was further explained that "*as more people have been joining and attending CARE training, and as no bad news has been reported about them, and as their livelihood has been improving ... we think it is worth joining and benefiting as they are*" (male farmer, program non-participant, Nyingwa village – interview statement, 2011).

Although local trust in outsiders has improved the participants of focus group discussions and key informant interviews are concerned about the fate of their

efforts – particularly they are sceptical about conservation intentions (i.e. about land confiscation and relocation). A key informant explained that “we are worried that this program has been secretly sent to the village by the government to promote tree planting which will become the property of the government” (male farmer, program participant, Kibungo village – interview statement, 2011). In addition, some program participants and non-participants are anxious about the concept of PES. Frequently, focus group discussion participants and key informants asked “*how can someone give you trees for free and also pay you money for planting them in your own farm?*” (male farmer, program non-participant, Dimilo village – interview statement, 2011).

5.4.2 Distribution of EPWS Program Outcomes

This section explores the distributional outcomes of the EPWS program in terms of the distribution of benefits. It examines distribution of program outcomes among the participants to more carefully understand how the program affected the most vulnerable households such as the poor and women.

5.4.2.1 Distribution of Outcomes According to the Household’s Wealth Quartile

While the average number of household sources of cash income for program participants when compared to non-participants in 1st and 2nd quartiles is more than two and one respectively, no statistically significant difference was observed among the groups following the Kruskal Wallis Test (Figure 5.10). Compared to the well-off households in the 3rd and 4th wealth quartiles, many households in 2nd quartile had more than one sources of cash income. This suggests that the poor

were not made worse in terms of their household's average number of cash income as a result of their participation in the EPWS program.

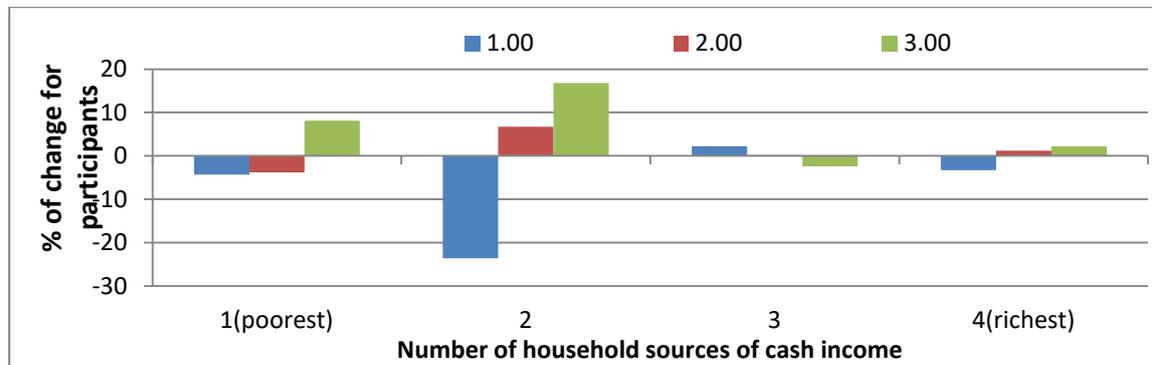


Figure 5.10. Wealth wise distribution of the number of household sources of cash income for program participating households when compared to non-participants (participants –non-participants)

Although there is positive change in the cash income for program participating households when compared to non-participants, no statistically significant differences are observed among the quartiles following the Kruskal Wallis Test (Figure 5.11). In all four wealth quintiles, household cash income was higher among the program participants and more difference is observed in 2nd and 3rd quartile compared to 1st quartile and 4th with richer households (Figure 5.11).

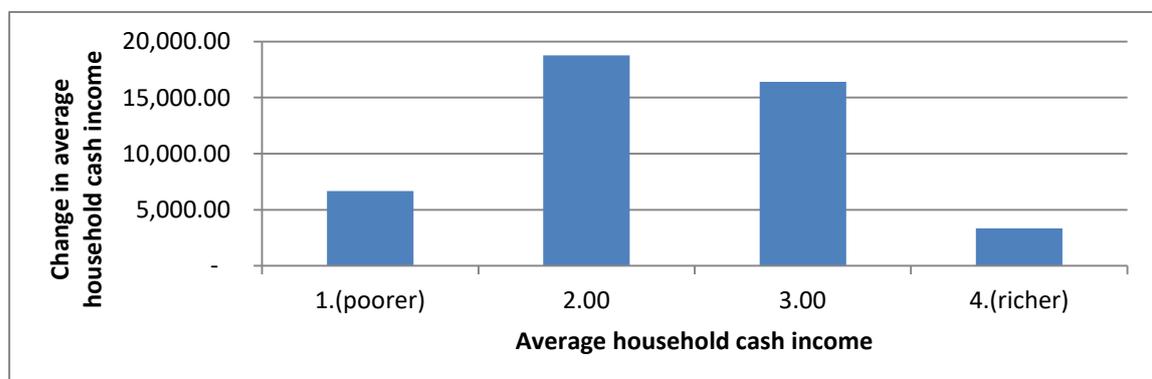


Figure 5.11. Wealth wise distribution of the cash income for program participating households when compared to non-participants

Only wage or salary was statistically different (Kruskal Wallis at $p < .05$ level of significance) among wealth quartiles when average cash income from different sources for program participants was distributed in percentiles (Figure 5.12). However, compared to the 1st, 2nd and 3rd quartiles, the 4th quartile had high share of cash income from different sources such as from the sale of crops (33.6%), sales of livestock (33.6%), business income (37.5%) and remittances (47.6%). The share of cash income from different sources for the 1st wealth quartile ranged from 24.7% for other casual earnings such as and 17.4% for business income.

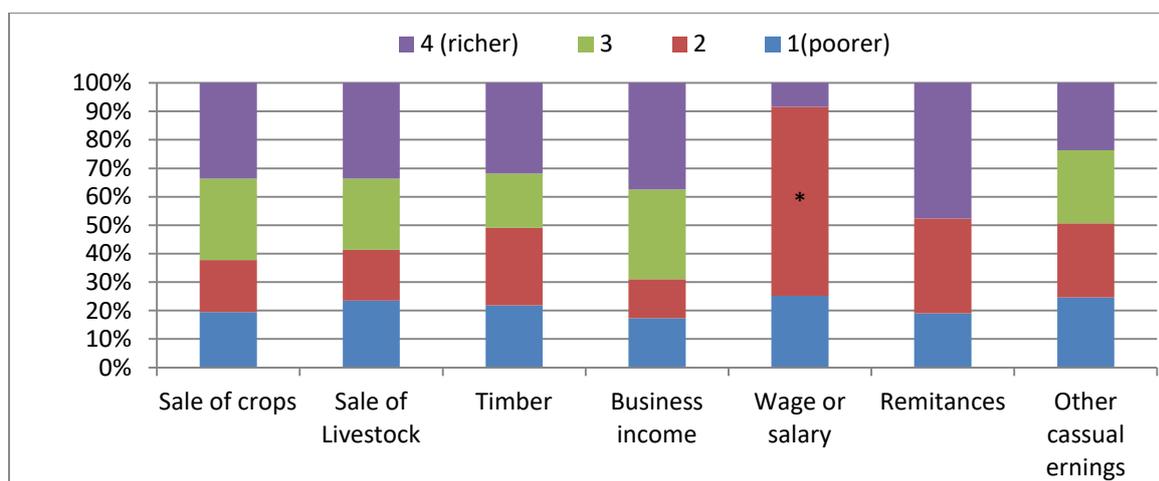


Figure 5.12. Distribution of average cash income from different sources for program participating households by wealth quartile.

Distribution of the EPWS program participating households in different affiliations according to wealth quartile is shown in Figure 5.13. In these affiliations, significant differences are observed in the 3rd quartile for households that are members in the school committee (Kruskal Wallis at $p < .01$ level of significance) and in village court (Kruskal Wallis at $p < .01$ level of significance), and in the 4th quartile for those who are members to the EPWS network group (Kruskal Wallis

at $p < .01$ level of significance). Unlike the 1st and 2nd quartiles, the better off in the 3rd and 4th quartiles are dominant in all affiliations as shown in Figure 5.13.

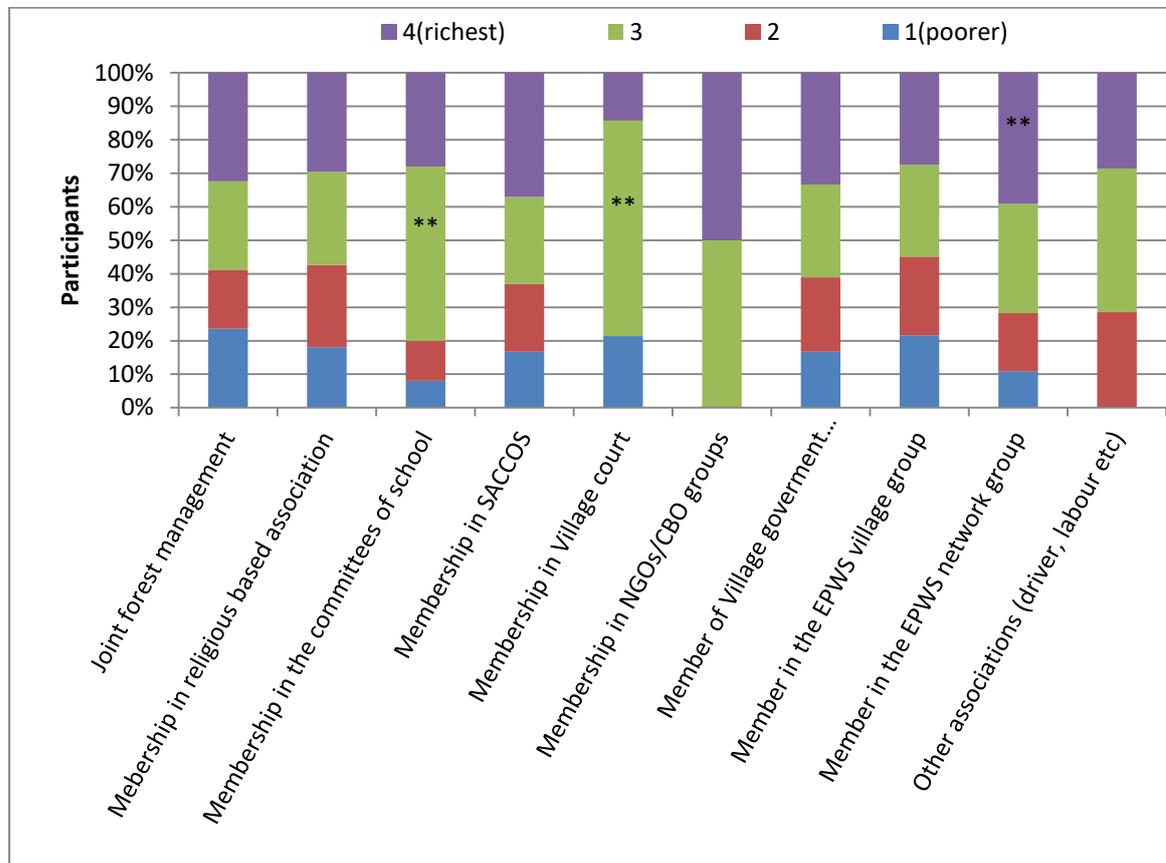


Figure 5.13. Memberships of EPWS participant's in various groups by the households level of wealth.

5.4.2.2 Distribution of Outcomes According to the Gender of the Household

Both females and males had more than two sources of household cash income (5.14). Compared to non-EPWS program participating households, fewer program participating male and female heads of households had less than one source of household cash income. However, many female headed households had three sources of household cash income compared to male headed households (Figure 5.14). These differences are statistically significant as revealed by Mann-Whitney U test at $p < .01$ level of significance. This suggests

that EPWS program did not decrease participant’s household sources of cash income for those with more than two sources.

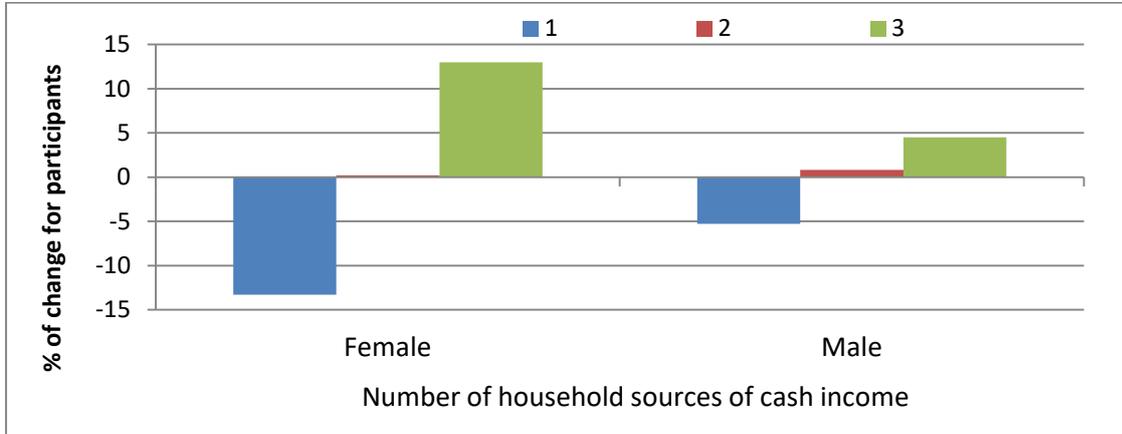


Figure 5.14. Gender wise distribution of the number of household sources of cash income for program participating households when compared to non-participants (change = participants – non-participants).

The household cash income of EPWS program participating households is high for both male and female headed households when compared to non participating households (Figure 5.15). However, while the difference for male headed households is greater than for female headed households, the difference is not statistically significant.

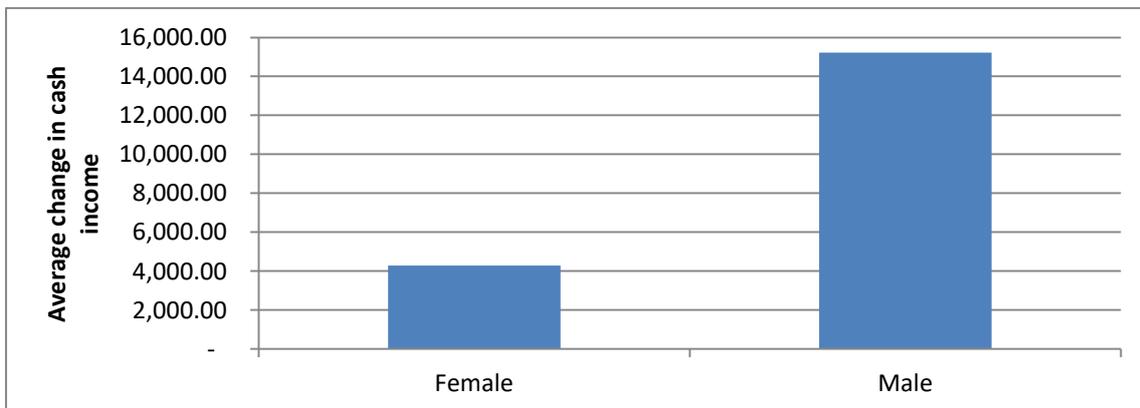


Figure 5.15. Gender wise distribution of the household cash income for program participating households when compared to non-participants (change = average cash income for participants – average cash income for non-participants).

Sales of livestock and business income are the only sources of cash income that are statistically different (Mann-Whitney U test at $p < .05$ level of significance) between male and female headed households (Figure 5.16). Nevertheless, male headed households constitute large share of the cash income from different sources as presented in Figure 5.16 compared to female headed households.

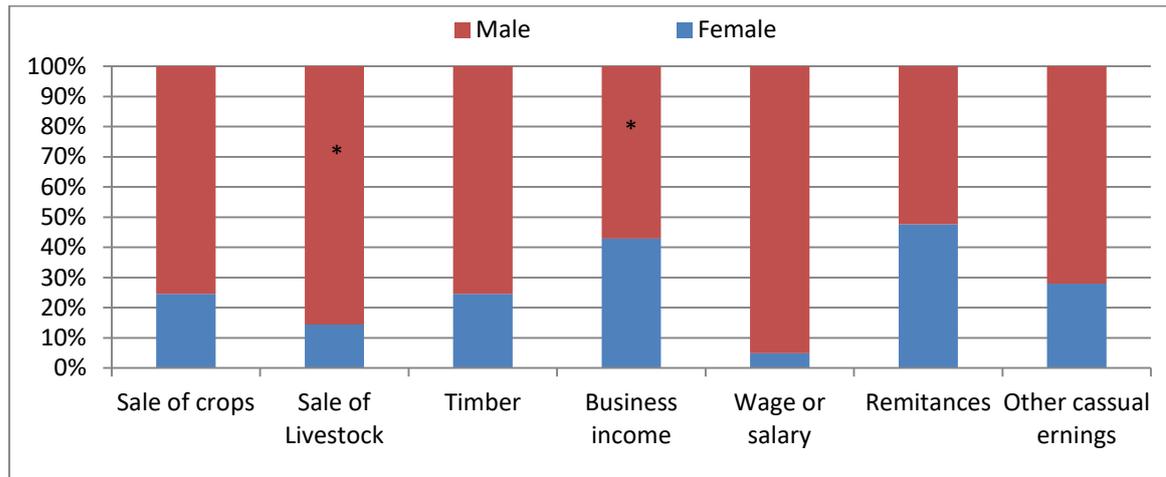


Figure 5.16. Distribution of various sources of cash income for program participating households by gender

Distribution of the EPWS program participating households in different affiliations according to the gender of household head is shown in Figure 5.17. In these affiliations, statistically significant differences are observed in male headed households based on memberships in SACCOS (Mann-Whitney U test at $p < .01$ level of significance) and in village government (Mann-Whitney U test at $p < .05$ level of significance). In both affiliations that households are associated, male headed households are more dominant than female headed households.

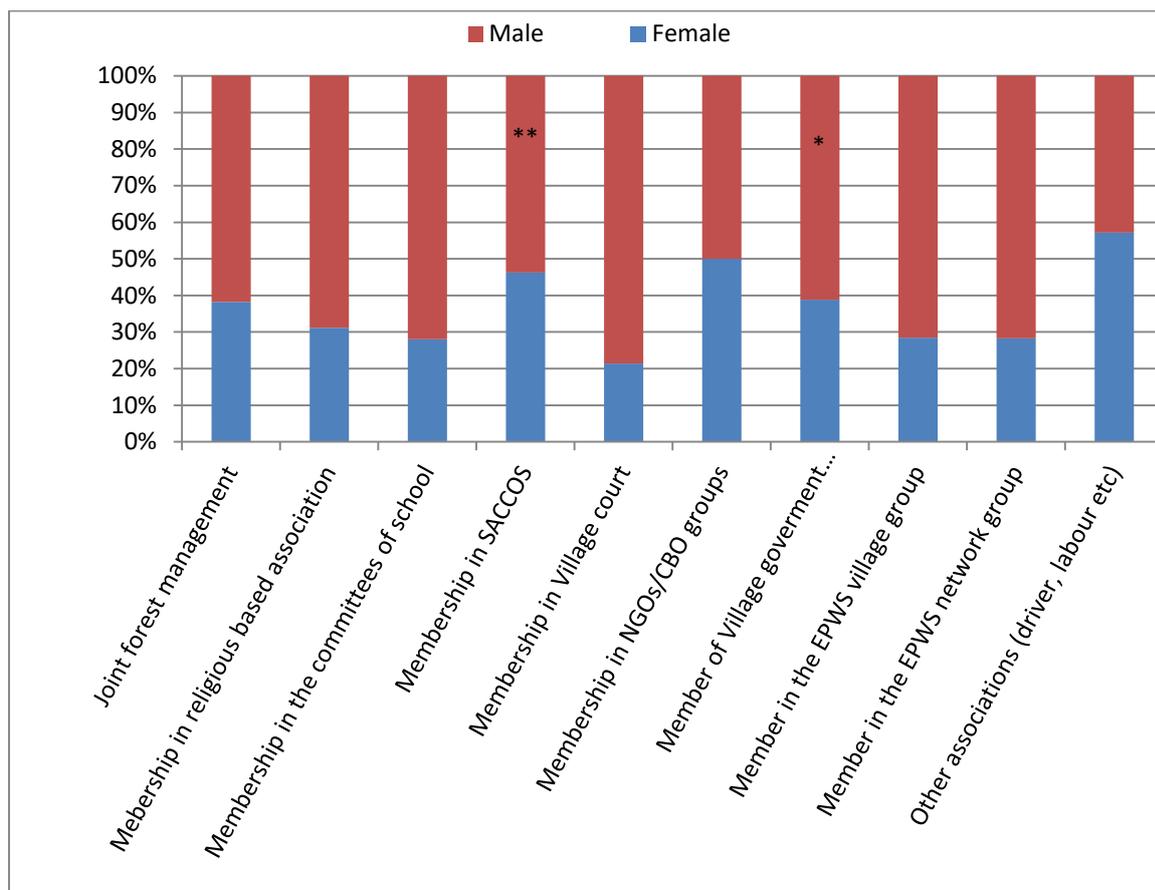


Figure 5.17. Memberships of EPWS participant's in various groups by gender of the household head.

5.5 Discussion

5.5.1 Direct and Indirect Financial and Non-financial Benefits

The objective of this chapter was to investigate the livelihood impacts of the EPWS program. The findings have shown the direct and indirect financial and non financial livelihood impacts of the EPWS program as well as the distribution of outcomes. The main mechanism through which a PES program is assumed to directly affect the livelihoods of the participants is through PES payments (Pagiola et al., 2005). This study has shown that EPWS payments to program participants accounted for about 20% of the annual household cash income on average. Generally, PES payments vary in their relative contribution to the

income of program participants. In Latin America, the payments were up to 30% of annual household income (Kosoy et al., 2008), over 10% in Costa Rica (Wunder, 2008b), and about 16% in the Virilla watershed in Costa Rica (Miranda et al., 2003). The important difference between these payments and the EPWS payments is that they are from forest based programs rather than from agro ecosystem based PES program which involves the adoption of SLM practices.

While a firm conclusion about the impact of PES program on livelihoods should not be based on the proportion of household income, it contributes alone (Zilberman et al., 2008), recipients of EPWS payments consider the payments to be an important source of income, paid in a lump sum that assisted them in catering for household needs that require large investment such as education, clothes, house improvements and farm tools. In general, these payments are important source of household cash income because, as demonstrated in these findings and in other PES livelihood impact studies conducted in rural areas in other developing countries, cash income opportunities are largely limited (Miranda et al., 2003; Kosoy et al., 2008; Zilberman et al., 2008).

In addition to the PES payments, other livelihood impacts of the EPWS program are indirect financial and non-financial impacts. The indirect financial impacts of the EPWS program included the increase in land value, employment opportunities, livestock keeping and crop production, and households' ability to meet food needs. Indirect livelihood impacts of the EPWS program are associated with the nature of the program as land modifying and activity creating (Zilberman et al., 2008). The program has resulted in the increase in the value of

land following the construction of terraces (i.e. bench terraces, *fanya juu* and *fanya chini*) and tree planting (i.e. agro forestry and reforestation).

Whilst the increase in the value of land is beneficial to land owners, to the landless poor and smaller landholders it is a misfortune. The once idle, uncultivated and marginal lands are now put into use by landowners as a result of promised benefits from PES payments and as savings for future generations (Cole, 2010; Lopa et al., 2012). As a consequence, the landless and small landowners have suffered from increases in agricultural land rent and reduced access to land. This has also been reported by German *et al.* (2010) in the Bushenyi District in Uganda where access to land among the landless was reduced as a result of the expansion of forest carbon sequestration in the Trees for Global Benefits Programme.

Furthermore, while the outcomes for the program participants are clearly positive, the chapter findings have also shown that the EPWS program has indirectly benefited both the program participating and non-participating households through wealth creation from crop yields and livestock keeping, and employment from daily and monthly casual labour and small business opportunities. This again is an impact which is associated with the nature of the EPWS program in which agricultural production activities are modified to achieve environmental objectives unlike the land diversion programs whereby land is diverted from agriculture to forest (Zilberman et al., 2008). These findings suggest that the application of PES on active agricultural land has higher potential to increase the demand for labour and production of crops than land diversion PES payments

that reduce labour demand and land for growing crops (Zilberman et al., 2008). This also suggests that the potential for poor participants to benefit from PES programs, such as EPWS, which promote the adoption of SLM practices such as terraces (i.e. bench terraces, *fanya juu* and *fanya chini*) and tree planting (i.e. agro forestry), is higher than in land diversion programs that focus on afforestation, reforestation and forest protection (Wunder et al., 2008; Zilberman et al., 2008).

Investment in SLM practices is one way through which the EPWS program has enhanced natural and financial capital assets of the participating households. This is in principle a key pillar of a PES program which consequently affects physical, human and social assets as indirect non-financial impacts of the program.

Capacity building within EPWS is one of the key factors affecting human capital among participants, delivered through internal and external training. These training improved access to information and implementation of SLM practices, strengthened local institutions, improving reciprocity and trust among the program participants, and extended internal and external networks, as well as increasing options for participants to diversify their income sources. The significance of improvement in human capital in the community suggests the existence of more benefits from the program to the community. This justifies the necessity of PES programs to invest in human capital, particularly in the development of transferable skills and capacities.

Capacity building through various forms of training such as local workshops and study tours is a significant aspect of a PES program. The importance of this is justified by the study findings that illustrate that wretched understanding of the PES concept was detrimental and raised scepticism and delayed enrolment in the program. The fear of land confiscation and relocation, and uncertainty about the ownership of trees signified the problem of poor understanding of the concept of PES in the EPWS program. This finding echoes the findings of Robertson and Wunder (2005) in the Los Negros River Watershed where the farmers distrusted the local PES initiative.

While cash transfer of payments is a widespread way to reward participants in PES programs (Wunder, 2005; Engel et al., 2008; Sommerville et al., 2009; Wunder, 2015), the findings from this study suggest that this approach is somehow problematic to some farmers given the finding that some interpreted cash payments as covert attempts to buy their land or forest. These findings highlight the need to familiarize participants and non-participants with the rationale and functioning of PES programs and to consider all forms of rewarding participants.

On the question of social capital, the findings suggest that the EPWS program has helped to expand and strengthen social relationships and networks, increase trust and reciprocity among community members and other social actors, and empower women and the poor. These outcomes are perhaps the result of the EPWS programs' choice to work on strengthening the capacity of existing local level institutions (Lopa et al., 2012). This approach has also been used by other

PES projects (Tacconi et al., 2010) with considerable positive outcomes, such as an enhanced sense of cohesion in communities and expansion of farmer networks beyond the community. In general, it can be argued that enhanced social capital helps to reduce household vulnerability and enhance the welfare of the poor both in terms of empowerment and poverty alleviation (Pagiola et al., 2005; Wunder, 2008b). Also, strong social capital can help to reduce the initial investment costs of the PES programs by allowing farmers to work in groups (Tacconi et al., 2010).

5.5.2 Distribution of EPWS Program Outcomes

Following the attractiveness of PES in developing countries, in contexts where poverty alleviation is often a desired co-benefit of conservation interventions, concerns about the distribution of outcomes have become more significant (Pagiola et al., 2005). This means that many questions about the effectiveness and efficiency of PES in achieving desired outcomes must be considered alongside poverty and, more generally, equity question. Therefore, with regard to poverty and equity questions, this study finds that the poor and women have not been made worse in terms of their households' average sources of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program.

The analysis of the findings indicates that program participating households in the low wealth category (1st and 2nd wealth quartile) have not been affected negatively in terms of their sources of cash income, household share of income,

average cash income and their affiliations or memberships. They have additional sources of cash income (Figure 5.10) when compared to non-participating households in the same quartiles and the participating richer households. The finding suggests that their sources of cash income are more diversified than their richer counterpart, implying that EPWS program could be the reason for providing additional income sources for poor land users, thereby helping to improve their livelihoods (Pagiola et al., 2005). Improved access to different sources of cash income is likely to be good for the poor program participating household's welfare, including food security.

The findings have also indicated that participation of the poor in the EPWS program has had no negative effect on household's cash income just like other wealth groups. The positive cash income can potentially be explained by improved efficiency in agricultural production induced by the increase of inputs, access to information and technical assistance from EPWS staffs and paraprofessionals, leading to increased average revenue of crop yields for program participating households. The share of the cash income for the poor from other sources such as the sale of livestock, timber, business income, wage or salary, remittances and other casual earnings was also positive.

As far as women are concerned, there is no indication that their welfare deteriorated as a result of their participation in the EPWS program. However, while female sources of cash income are more diversified than their male counterparts, average cash income for male headed households is higher than for female headed households. Also, the share of cash income from all sources

identified in the study (Figure 5.15) are higher for male headed households compared to female headed households. Furthermore, male headed households are dominant in all affiliations with significant differences in their SACCOS and village government memberships. In a similar assessment of PES program in rural Mexico, only 20% of women were full members in ejidos, communal land tenure organizations through which agreements are implemented (García-Amado et al., 2011).

These findings are not surprising because measuring gender where land ownership is culturally assigned to a male member of the household is challenging as statistics tend to be skewed. However, a positive impact of the program is that women participated in the program and their welfare was not degraded. This is despite the fact that land engaged mostly for program activities was non clan land mostly owned by males and not the clan owned land mostly under women through matrilineal system (Englert, 2008). Individualization of land has increased and land inheritance through the male members of households has become more common in the Uluguru Mountains (Van Donge, 1993b; Van Donge, 1993a; Lyamuya et al., 1994; Hymas, 2001; Englert, 2008).

5.6 Conclusion

In this chapter, the direct and indirect livelihood impacts of the EPWS program on participants and non-participants have been examined. The findings have shown direct financial and indirect financial and non-financial livelihood impacts of the EPWS program. Also, with regard to poverty and equity questions, the study finds that the poor and women have not been made worse in terms of their

household's average number of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program.

While the cash payments to participants in return for the adoption of SLM practices are important, it appears that the majority of the program participants consider other forms of incentives such as training, supply of manure and improved seeds as more important. This does not however undermine the importance of direct cash payments to households as they enabled farmers to make investments that would not have been possible otherwise. Equally, indirect financial and non-financial benefits of the EPWS program suggest the importance of agricultural based PES programs in the improvement of rural livelihoods and poverty alleviation in addition to achieving environmental goals.

The indirect financial benefits of the EPWS program which included increased crop yields, increased value of land, and increased employment opportunities are essential in alleviating rural poverty. Combined with strengthened institutions, increased trust, expanded internal and external networks and increased knowledge of farmers and capacity in farming, leadership and business, the impacts could be substantial. All of these are transferable assets which can underpin activities outside the PES program and thus offer potential to enhance rural development. Increased value of land translated to higher land rents and reduced availability of land however, which adversely affected the access of land to landless and land-poor households. This clearly requires greater attention during the design of PES programs.

The findings have also highlighted the importance of indirect financial and non-financial benefits to farmers compared to cash payments. This would not be the same in a situation where the focus of PES programs is on forests, in which financial incentives are the key motivation for participation of land owners. Overall, the study highlights the need for more research on the potential for and implications of PES programs in agricultural systems in other developing countries, particularly in agro-forestry and inter-cropping systems, to fully understand their ability to deliver both on ecological and livelihood improvements.

Chapter 6: The Effectiveness of the EPWS Program to Increase Water Quantity and Quality Supply Downstream.

6.1 Chapter Outline

This chapter evaluated the effectiveness of the EPWS program in terms of its additionality, leakage effects, permanence of SLM practices and cost effectiveness in the supply of water ecosystem services. Mixed methods quasi-experimental design with propensity score matching method was used to establish the counterfactual effect of the program from the data collected from both program participants and non-participants. The findings suggest that the program has had additionality effects, positive leakages and promising sustainability of adopted SLM practices as well as positive measures for cost effectiveness. On additionality, the findings show that, the land under agro-forestry and reforestation practices increased by 6.92% amongst program participants. Also, more program participants use organic fertilizer, practice integrated pest management and plant woodlots. In addition, the program has also resulted in positive leakages such as decreased incidences of forest fire, forest encroachment and illegal logging. On sustainability, the findings show that once established, SLM practices are privately more profitable to farmers and so are likely to be retained.

6.2 Introduction

In agro-ecosystems, payments for ecosystem service transfer positive incentives to farmers conditional to the supply of well-defined ecosystem services (Wunder,

2005; Wunder, 2007). These incentives are expected to change conservation behavior of farmers in a way that will sustain and increase the supply of ecosystem services compared to what would have happened without an intervention (Wunder and Börner, 2011a). In Tanzania, the EPWS program has promoted sustainable land management practices such as terracing, agro-forestry, afforestation and the sharing of associated technical knowledge to farmers in four villages of Kibungo Sub-catchment in the Uluguru Mountains. The aim is to reduce the use of farming techniques that cause nutrient mining, soil erosion, accelerated turbidity levels and thus reduce water treatment costs for water companies downstream (Lopa and Mwanyoka, 2010; Lopa et al., 2012).

However, the effectiveness of EPWS program to improve water quality and quantity has not been rigorously examined. Existing studies on EPWS program have reported its development, initial impacts, operationalization and payment mechanism (Branca et al., 2011; Lopa et al., 2012). Also, compared to well established agro-ecosystem PES programs in developed countries such as the American and European agro-environmental schemes (Kleijn and Sutherland, 2003; Primdahl et al., 2003), there is less understanding of the effectiveness of agro-ecosystem PES programs in supplying ecosystem services in developing countries (Ferraro, 2009b; Branca et al., 2011; Schomers and Matzdorf, 2013).

Contributing to this knowledge gap, this chapter examines the effectiveness of the EPWS program intervention activities in affecting individual behaviours that improve water quality and quantity to downstream users. It examines the program additionality, leakage, its sustainability or permanence in providing the services,

and cost effectiveness. These are significant concerns about the effectiveness of PES programs as described by scholars like Ferraro and Pattanayak (2006), Wunder (2007), Jack et al.(2008), Wunder et al. (2008) and Ferraro (2009a). These attributes are further discussed in the next section.

6.3 The Effectiveness of PES Programs to Deliver Ecosystem Services

In PES programs, payments to service providers are thought to change their behaviours in ways that will enhance the supply of ecosystem services compared to what would have occurred in the absence of an intervention (Ferraro and Pattanayak, 2006; Ferraro, 2009a; Ferraro and Hanauer, 2014). This condition is identified as additionality - a determination of whether PES program intervention actually results in outcomes - i.e. land use and behavioural changes that are additional to what would have happened in the absence of the intervention or compared to baseline (Sierra and Russman, 2006; García-Amado et al., 2011) (Wunder, 2007; Engel and Palmer, 2008). Where funds for PES are limited, lack of additionality would be inefficient economic intervention because service buyers seek to make payments on practices that would not have happened without payments (Wunder, 2007; Engel et al., 2008; Jack et al., 2008). In this context, PES payments are expected to be the causal factor of positive change in land status (Wunder et al., 2008) and de facto change in land owners behaviour to generate environmental benefits (Sierra and Russman, 2006). According to Ferraro (2002) incentives should be aligned directly and explicitly with resource protection. The logic is to pay for what generates additional environmental

services compared to program counterfactual and not pay for practices that would have been undertaken anyway (Ferraro, 2002; Ferraro and Kiss, 2002; Milne and Niesten, 2009). As such, concerns over the additionality in PES programs have been raised: that PES may not in fact induce the desired land use changes and/or ecosystem services.

Additionality is of greater interest to funders of environmental management interventions and the wider community, as it is essential for assessing intervention impact (Engel et al., 2008). However, while, additionality is frequently used as an indicator of PES effectiveness, it is extremely difficult to demonstrate due to practical and methodological challenges of measuring the service itself, estimating baselines and identifying leakage (Aukland et al., 2003; Wunder, 2007). With respect to leakage, Sommerville et al., (2009) show that prior estimation of spatial and temporal scales at which an intervention will be additional is vital to allow the comparisons of outcomes. However, due to the challenges of establishing additionality, these estimates are addressed qualitatively (Sommerville et al., 2009).

Leakage or the shift of environmental problems from one place to another happens when damaging pressure (i.e. deforestation) from land receiving PES payments is shifted into neighbouring or other lands that are not under contracts or receiving payments (Wunder, 2007; Wunder et al., 2008; Bremer et al., 2014). In this context, leakage (positive externalities) is considered as an unintended impact of PES intervention, especially when non-crop land is brought into crop production when a PES program recipient clears one plot of land to substitute for

another under a conservation contract (i.e. afforestation or reforestation) (Wu, 2000). For example, for every 100 acres of land removed from crop production under the Conservation Reserve Program (CRP) in the central United States, 20 acres of non-cropland were brought into crop production (Wu, 2000). Leakage can also occur indirectly when the establishment of PES conservation practices, such as conservation of forest or promotion of land diversion, reduces land available for food production, and so increases food prices and/or deforestation elsewhere to produce food (Wunder et al., 2008).

In addition to additionality and leakage, longer-term permanence of land use changes and supply of ecosystem services induced by short-term intervention remain a vital concern for most PES programs (Napier, 1991; Wunder, 2007; Jack et al., 2008; Ferraro and Pressey, 2015). Creating a long lasting supply of ecosystem services has been acknowledged as a prerequisite for PES program success because most PES contracts are not made indefinitely (Wunder, 2007; Engel et al., 2008). Under voluntary transactions principle, service providers can decide to end the implementation of introduced conservation practices when the payment ends (Nkonya et al., 2005). In a situation like this, a PES program will be considered ineffective in the provision of ecosystem services if it results in the abandonment of practices when payments end (Wunder, 2007).

The costs at which additional ecosystem services are achieved are significant in explaining the effectiveness of a PES program (Jack et al., 2008; Wunder et al., 2008). These costs include the service providers' opportunity costs of benefits

foregone from alternative land use and the initial costs of establishing and maintaining improved land use practices (e.g., construction of terraces, agro forestry and maintenance of trees) (Wunder et al., 2008). In addition to investment and maintenance costs on the providers' side, these costs occur on the buyers' side as well. On the buyers' side, transaction costs can be defined as all costs which are not payment proper which can be divided into start up and running costs (Wunder et al., 2008). With regard to the role of costs in PES program participation, it has been argued that rational decision makers (the potential service provider) are unlikely to accept payment unless the payments exceed their opportunity costs and the costs of establishing and implementing the desired activities (Jack et al., 2008). A PES program could be cost effective, if the service providers were able to receive payments that cover their opportunity and investment and maintenance costs of participation (Engel et al., 2008; Wünscher et al., 2008). Other costs are the transaction costs incurred by a PES program implementing agency or organisation. These costs arise from PES program establishment requirements (including information procurement such as performing scientific baseline studies, program design and negotiation costs) and recurrent costs of implementation (including payment administration, monitoring and sanctioning) (Pagiola and Platais, 2002; Wunder, 2007; Wunder et al., 2008).

Although the effectiveness of an agro-ecosystem based PES program can be explained by its additionality, leakage effects, permanence and involved costs such as transaction and opportunity costs, most studies are considered to lack rigorous evaluation (Ferraro and Pattanayak, 2006; Pattanayak et al., 2010; Tacconi et al., 2010). According to Ferraro and Pattanayak (2006), rigorous

evaluation creates inferences about unobserved counterfactual outcomes that would have occurred without the intervention. However, this is difficult to articulate due to non-random nature of the design of many PES programs and associated difficult to disentangle the effects of an intervention or program (i.e. conservation impacts such as change in land use) from the effects of other policy measures and broader economic trends (Ferraro and Simpson., 2002; Ferraro and Pattanayak, 2006; Wunder, 2007; Margoluis et al., 2009; Djamhuri, 2012).

Quasi-experimental research design can address the counterfactual problem (Flanders, 2006; Ho et al., 2007) as illustrated in chapter 2 section 2.4 and chapter 3 where the causal-effect model (section 3.2.3) and the propensity score matching and implementation (section 3.6) are explained. However, there are numerous challenges that are encountered in evaluating conservation programs including PES.

6.4 Challenges of Evaluating Conservation Interventions - PES

One of the challenges in evaluating the success of conservation projects like PES is the time lag between the intervention and realization of measurable impacts which is often very long that conservation impacts occur outside project time frame (Ferraro, 2009a; Prowse and Snilstveit, 2010). Changes to ecosystem services (i.e. improved water quality and quantity) that are attributable to a particular intervention are difficult to establish because of life cycles and natural fluctuations in species and ecosystems that occur over many decades (Mary, 2001).

Another challenge in conducting impact evaluation of PES is the lack of appropriate baseline data, due to rare incorporation of evaluation component in the programs design phase (Ferraro, 2009a). Evaluation of outcome or impact is often an afterthought issue with no attention to evaluation requirements at program inception (Ferraro, 2009a). Consequently, no baseline data are collected before the intervention, and little or no good data are collected during the project life appropriate for evaluation.

Also, conservation intervention whether at large scale or small scale works in complex, dynamic, and often unpredictable settings that can cause under-reporting or over-reporting of the outcomes or impacts of an intervention (Wunder, 2007; Jack et al., 2008). Due to complex spill-over effects, intervention effects can go beyond the recipients and the area of an intervention that might not be captured or underestimate outcomes due to crowding in effects (Wunder, 2007; Ewers and Rodrigues, 2008; Wunder and Albán, 2008). For example, interventions in agro-ecosystem that are packaged with technical assistance and marketing efforts could make some of promoted SLM practices so profitable that they are expanded into previously unused land to increase income (Ewers and Rodrigues, 2008; Wunder and Albán, 2008; Wunder and Börner, 2011b). Furthermore, when PES intervention affects productivity, prices of goods and labour market, it can trigger unintended land use change pressure in areas not targeted by PES program (Wunder and Börner, 2011b).

The scale at which intervention is implemented poses another challenge for outcome or impact evaluation of PES programs. Many PES programs have been

implemented in small catchments as pilot programs. Small scale coverage of PES program like EPWS intervention makes it impractical to conduct measurements of water quality and quantity downstream (Lopa et al., 2012). Related to this is the likelihood that water quality and quantity can be reduced by what is happening between the areas of intervention and water quality and quantity measurement area or where improved services are expected to benefit. Unsustainable land use activities of farmers who lie between the areas where interventions are carried out can greatly reduce water quality and quantity downstream and thus compromise the effectiveness of the upstream intervention.

Also, it is very challenging to conduct measurement of improved water quality and quantity in an intervention like EPWS program where some farmers participated in the implementation of SLM practice and others did not (Lopa et al., 2012). In a situation like this, little improvement in the measurements of water quality and quantity may not be explained by the ineffectiveness of the program as the activities of those who did not participate in the program might be the reason for lack of improvement (Lopa et al., 2012). Furthermore, as other farmers may still be in the process of adopting SLM practices, measurements of water quality and quantity could result in the underreporting of outcomes.

6.5 Assessing Effectiveness in Conservation

Acknowledging the barriers that environmental practitioners and scientists encounter in conducting impact evaluation of conservation interventions, Ferraro (2009a) argues that challenges or barriers stipulated above are not limited to the

field of environmental policy; they are also pervasive in all social policy fields. Consequently, Ferraro (2009a) suggests that, since many environmental programs are aimed at affecting human behavior, either as individuals or as collectives, measuring intervention impacts on the intermediate outcomes or impact of behavioral changes can overcome some of the challenges involved in evaluating environmental outcomes and impacts of conservation interventions (Sabourin and Lamarche, 2005; Ferraro, 2009a). Conservation interventions work by changing behaviors responsible for environmental problems (Sabourin and Lamarche, 2005). Thus, examining the causal mechanisms linking a policy intervention with behavioral change, such as intervention activities on behavior is vital (Scullion et al., 2011; Thomas and Koontz, 2011).

Conservation initiatives involve diverse types of activities which influence conservation targets directly or indirectly and that may each contain different outcomes and suitable measures of success (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010). Payments are not the only incentives from a PES conservation intervention that impact individual decisions. Individuals, can indirectly be influenced by other positive and negative incentives within a larger socio-political framework that can influence conservation indirectly such as those which enhance or provide alternative livelihoods, policy and legislation, education and capacity building (Kapos et al., 2010).

Conceptually, activities that influence conservation indirectly are remote from conservation targets. However, each can have key outcomes that occur earlier in the sequence and which are fundamental to reducing threats to ecosystem, or

improving responses of conservation targets (Kapos et al., 2009). For livelihood related activities, the key intermediate outcomes are the change in resource use behaviour, abandonment of the relevant damaging practices or uptake and maintenance of sustainable practices. As for capacity building, education and awareness rising, the intermediate outcomes are the increase in the quality of conservation action and change in behaviour by the intended audience targeted by the work. As regards policy and legal work, the intermediate outcome is the enforcement of policies or legislation promoted' (Kapos et al., 2009, p.339). These conservation activities are interlinked, as they can collectively or individually lead to numerous intermediate outcomes such as those shown in Table 6.1 (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010).

As these conservation activities have intermediate outcomes that occur earlier, for which information is available and easier to measure, the effectiveness of conservation intervention can be evaluated in terms of its additionality, leakage, permanence and cost effectiveness (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010). This chapter therefore, uses the EPWS program as a case study and employs quasi-experimental mixed methods approach (see Chapter 3) to evaluate the additionality, leakage, permanence and cost effectiveness of an agro-ecosystems based PES program intervention to deliver water quality and quantity to downstream users.

6.6 Materials and Methods

This chapter follows the generic descriptions of case study and methods described in chapter three to evaluate the environmental effectiveness of the

EPWS program in terms of its additionality and leakage effects as well as sustainability and cost effectiveness to provide water service (water quality and quantity) to downstream water users. In order to overcome the time lag challenge involved in evaluating conservation impacts that occur outside the project time frame, the study focuses on the evaluation of intermediate outcomes of the intervention that occur earlier, for which information is available and thus easier to measure (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010). Also, the study elicits local peoples' perceptions of the effectiveness of the program through interviews, surveys and participatory rural appraisal methods, as has been widely used in conservation impact studies in developing countries (Sabourin and Lamarche, 2005; Lund et al., 2009; Lund et al., 2010; Scullion et al., 2011; Veríssimo, 2013). This approach has been used by Agrawal and Chhatre (2006) to assess forest conditions, Husain and Bhattacharya (2004) to assess forest area, Paré *et al.*, (2010) to assess forest degradation, Meshack *et al.*, (2006) to assess forest regeneration, and IFRI (2008) to assess species diversity and vegetation density.

Studies that build on local perceptions and knowledge are considered to be highly cost effective (Danielsen et al., 2005; Lund and Treue, 2008; Anadón et al., 2009; Lund et al., 2009; Lund et al., 2010). While this study focused on behaviour change and perception as they constitute low cost and technology useful for research and development projects in developing countries, the approach was viewed in relation to other methods such as remote sensing and inventory methods (Lund et al., 2009; Lund et al., 2010). However, whilst remote sensing methods are also low cost, they are not very effective in detecting

changes in farm and forest quality beyond changes in farm size and forest cover over significant period of time (Lund et al., 2009; Lund et al., 2010).

Essential attributes of an effective PES program outlined in section 6.2 and in Table 6.1, namely additionality, leakage, permanence and cost effectiveness (Wunder, 2007; Jack et al., 2008) framed the evaluation indicators. Data generated through propensity score matching (3.6) with 116 program participants and 116 non participants were used. The household questionnaire included closed and open ended questions used to collect data on observed and perceived environmental outcomes of EPWS intervention in terms behaviour change. Perceptions on behaviour change from both participants and non-participants were assessed on various indicators used to assess the effectiveness of the EPWS program shown in Table 6.1. In addition, sixteen focus group discussion (FGDs) and thirty two key informant interviews (KIIs) were performed with program participants and non-participants. Stratified purposeful and extreme case sampling for the purpose of learning from highly unusual issue were used (Margoluis et al., 2009). Therefore, focus group discussions and key informant interviews were used for the purpose of validating respondents' perceptions through triangulation which involved asking the same question asked from one method such as in household interviews to key informants and focus group discussions to enhance construct validity of the method (perception-based methods).

Table 6.1. Data types and sources for examining the attributes of PES effectiveness

Effectiveness attribute	Assumption	Question	Source of data
Additionality	- Program participants have more land under agroforestry and reforestation than non-participants	- Percent of farm under agroforestry and reforestation	HS
	- Program participants have many SLM practices than non-participants	- Number of SLM practices i.e. Terraces (bench and <i>fanya juu</i> terraces, grass strips, trash lines, afforestation, contour bunds, riparian reforestation and agro forestry.	HS, KII & FGD
	- No difference between program participants and non-participants in tree planting behavior before EPWS 2008.	- Has your household planted any woodlot or trees on farm before EPWS 2008?	HS & KII
	- There is significant difference between program participants and non-participants in tree planting behavior after EPWS 2008.	- Has your household planted any woodlot or trees on farm after EPWS 2008?	HS & KII
	- Fewer program participants use chemical fertilizers than non-participants	- Do you apply chemical fertilizers in your farm?	HS
	- More program participants apply organic fertilizers than non-participants	- Do you apply organic fertilizers in your farm?	HS
	- More program participants apply integrated pest management than non-participants	- Do you practice integrated pest management?	HS
	- Fewer program participants practice slash and burn agriculture than non-participants	- Do you practice slash and burn agriculture	HS
	- Game and wildlife numbers\diversity increased	- How do you compare game and wildlife numbers\diversity now with before EPWS -2008?	HS & FGD
	- Sign of natural regeneration in degraded areas increased now with EPWS compared to before EPWS	- How do you compare sign of natural regeneration in degraded areas now with before EPWS -2008?	HS & FGD
Leakage	- Incidences of forest fire decreased	- How do you compare incidences of forest fire now with before EPWS -2008?	HS & FGD
	- Encroachment into the forest for agriculture decreased	- How do you compare incidences of people encroaching into the forest for agriculture now with before EPWS -2008?	HS, KII & FGD
	- Incidences of illegal forest logging decreased	- How do you compare incidences of illegal forest logging now with before EPWS - 2008?	HS, KII & FGD

Permanence	- People are willing to join and keep SLM practices without EPWS payments	- Why implement and keep SLM practices?	HS, KII & FGD
	- Benefits of SLM practices are higher than costs	- What are the benefits of the SLM practices	KII & FGD
	- Importance of PES payments compared to other benefits of the program	- Are benefits of SLM practices higher than costs - How important payments are compared to other benefits?	FGD
Cost effectiveness	- Costs of introducing and monitoring SLM practices are low	- What mechanisms are used to promote and monitor SLM practices?	KII& FGD
	- Farmers are able to overcome SLM adoption costs	- Were payments sufficient to cover adoption costs? - Are there any challenges encountered in adopting SLM practices	HS, KII& FGD
	- Program intervention intensives were important	- What incentives were important?	KII& FGD

Key: HS-Household Survey, KII-Key Informant Interview) and FGD-Focus Group Discussion

A propensity score matching technique (Chapter 3) was used to match the treatment group (program participants) with control group (non-participants) (Table 3.18 and 3.19) for attribution purpose. A simple difference approach (Baker, 2000) was used to assess the effectiveness of EPWS program to deliver ecosystem services. Household data was analysed using descriptive statistics and attributes of interest (Table 6.1) compared between the EPWS program participants and non-participants. Relevant themes and quotes were drawn from focus group discussion and key informant interviews to support quantitative data (Neuendorf, 2002).

6.7 Results

6.7.1 Estimates of the Program Additionality Effects

The estimate of the additionality effect of the EPWS program on the change in the behaviour of program participants as a result of program activities when

compared to non participants is positive (Table 6.2). Statistically significant changes are observed for the increase in the number of conservation approaches practiced by a household and increased proportion of program participants planting woodlot/trees on their farm after EPWS program, using organic fertilizers and practicing integrated pest management systems (Table 6.2). In addition, the finding in Table 6.2 shows that on average, program participants have 6.92% more land under agro-forestry and afforestation practices that would not have happened without EPWS program. With respect to the number of conservation practices, the program participants had a significantly higher number of practices than non-participants. Furthermore, more program participants had planted significantly more trees on their farms after EPWS and increased the use of organic fertilizers and integrated pest management.

Table 6.2. The effect of the EPWS program on respondents behaviour change

	Mean Difference between participants and non-participants	Std. Error Difference between participants and non-participants	Minimum	Maximum	t-test
Percent of land under agro-forestry and afforestation	6.92	2.60	10	95	2.67
Number of conservation approaches	0.98	0.13	1.00	6.00	7.53**
Has your household planted any woodlot or trees on farm before EPWS 2008?	0.09	0.06	0	1	1.47
Has your household planted any woodlot or trees on farm after EPWS 2008?	0.19	0.05	0	1	4.02**
Do you apply chemical fertilizers in your farm?	0.01	0.01	0	1	1.00
Do you apply organic fertilizers in your farm?	0.28	0.06	0	1	4.42**
Do you practice integrated pest management?	0.22	0.06	0	1	3.64**
Do you practice slash and burn agriculture	0.00	0.04	0	1	1.00

Note: Minimum 0 =No and Maximum 1=Yes. Analysis for statistical significance refers to statistical independent samples t-test for differences in means of two different groups of samples derived from Mann-Whitney U. **P<0.01, *P<0.05. Field data collected in household questionnaires between March and May 2011.

According to the key informant interviews conducted with EPWS officer, between 2009 and 2010 more than 170,000 trees were planted by the program participants and their survival rate was 85% in May 2011. In 2011, more than 93,622 trees were planted by both program participants and non-participants. This happened after landowners who did not want their names registered with the program were granted permission from the EPWS program to collect tree seedlings from the program seedling nursery. However, as shown in Figure 6.1, the uptake of SLM practices including terraces (bench terraces and *fanya juu*), afforestation and contour bands (banana and pineapples) for EPWS program participants is significantly higher than that of non-participants.

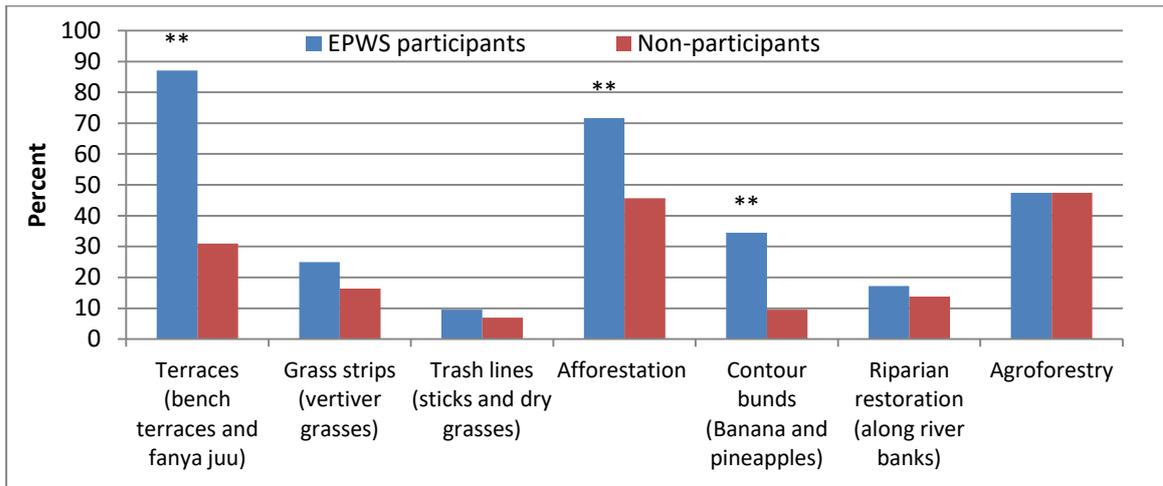


Figure 6.1. SLM practices implemented by program participants and non-participants.

Note: 1: Analysis refers to statistical independent samples t-test for differences in means of two different groups of samples. ** $P < 0.01$, * $P < 0.05$. Field data collected in household questionnaires between March and May 2011.

Uptake of afforestation was significantly higher among program participants while the uptake of agro-forestry practices did not show difference between program participants and non-participants. Key informant interviews and focus group discussions suggested that agro-forestry was relatively compatible with the existing land use system and easy to implement (Figure 6.1). Agro-forestry was in-line with pre-program farming system of both program participants and non-participants. A female key informant in Lanzi village said that *“agro-forestry is easy to implement on a small piece of land compared to the establishment of afforestation which would require more land”*. According to focus group discussions, farmers who have adopted agro-forestry interventions plant trees at the boundaries of farms to avoid in-farm competition with other crops and other trees are planted in erosion hotspots.

According to CARE key informant and focus group discussions, tree seedlings were made available to participants by EPWS through the establishment of a tree nursery in each program village. In addition, 18 households established their own tree nurseries with a variety of tree seedlings of their own choice. Tree species planted in the project and on farm nurseries included exotic fruit trees such as mango *Mangier indicia*, orange *Citrus sinensis*, avocado *Persea Americana*, livestock fodder *Leucaena leucocephala*, and *Casuarina* spp., *Allanblackia stuhlmannii* for oil bearing fruits and trees for timber including *Grevillea robusta* and the native *Faidherbia albida* and *Khaya anthotheca*.

6.7.2 Leakage Impacts of the EPWS Program

On leakage effects of the EPWS program, there are no significant differences between the perceptions of the program participants and non-participants of incidences of forest fire, encroachment into the forest for agriculture and illegal forest logging (Table 6.3). According to 80% of program participants and non-participants during household questionnaire, incidences of forest fire, encroachment into the forest for agriculture and illegal forest logging had decreased by 2011 compared to 2008 before the EPWS program began. The main source of forest fire was said to be fire started to clear and prepare farms for cultivation and keep away snakes. According to the focus group discussions, program activities which involved training, establishment of fire control groups and fines have been very effective in stopping the use of fire in preparing farms.

Table 6.3. Respondents' perception of the effect of the EPWS program on community behaviour change that threatens forest quality now (2011) with EPWS intervention compared to past 2 years before (2008)

	Mean Difference between program participants and non- participants	Std. Error Difference between program participants and non- participants	Minimum	Maximum	t-test
Incidence of forest fire	0.15	0.07	1.00	5.00	1.61
Encroachment into the forest areas for agricultural land	-0.05	0.08	1.00	5.00	-0.64
Illegal forest logging	0.12	0.07	1.00	5.00	1.71

Note: Minimum and maximum represent Likert Scale values where 1=Decreased a lot, 2=Decreased a little, 3=Remained same, 4 Increased a little and 5=Increased a lot. Field data collected in household questionnaires between March and May 2011.

With respect to encroachment into forest to establish or expand agricultural land, the survey results show that 84% of program participants and 92% of non-participants surveyed consider this practice to have decreased greatly. The average size of plots farmed by program participants for various crops has increased from 2.4 acres to 2.9 acres between 2008 and 2010 and plot sizes farmed by non-participants have increased from 1.9 acres 2.4 acres over the same period. According to focus group discussions, this has been a beneficial increase in the use of steep sloped land which was not in use for crops and planting trees.

Illegal forest logging was also reported to have significantly decreased as indicated by 75% of program participants and 83% of the non-participants. According to focus group discussions, training provided to program participants and non-participants in village workshops and public village meetings, a fear of relocation and of being fined cash were the main factors that contributed to a reduction in forest encroachment, illegal logging and setting fires. Collective

responsibility was described by the focus group participants and key informants as the best method of ensuring protection of the forest reserve against encroachment by agriculture, illegal logging and fire. These activities were described as risky activities which were secretly reported to the village authorities and forest office. A key informant in Lanzi village explained that *“it is not possible to tell who will report you if you break the rules because all people in the community are guards. We don’t want one person’s illegal activity to cause relocation of the whole community”*. The secret reporting was considered successful because in 2011, among others, the former council leader was secretly reported for illegal timber possession and was fined TSH 500,000 (US\$ 323).

6.7.3 Permanence

Survey findings show that 73% of program participants were willing to continue the implementation of the introduced SLM practices and 62% of non-participants were planning to join the program (Figure 6:2). According to focus group discussions conducted with the program participants, training provided by the program was perceived to have enabled an increase in crop yields alongside the construction of terraces. Also, expected benefits from timber harvests and fruit trees and increase in fertility have motivated program participants to continue implementation of SLM practices and non-participants to join. A male farmer, program participant in Nyingwa village explained that *“we are planting these trees for our future source of income from timber and fruit sales and for our children’s source of building materials”*. Another female farmer, program non-participant in

Lanzi village explained that *“in addition to planting trees for timber, they are very important source of fire wood which will save us time we use to walk and collect fire woods”*. Other reasons explained by the participants of focus group discussions were the future increase in non-timber forest products, control of landslides and erosion, micro-climate regulation and water retention.

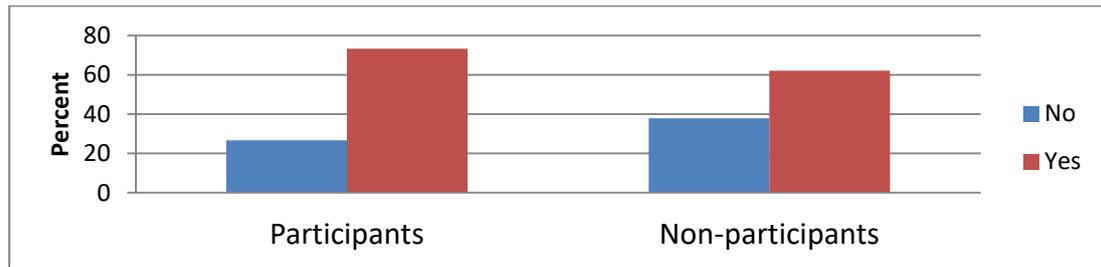


Figure 6.2. Program participant’s willingness to continue with EPWS and non-participants planning to join the program. Field data collected in household questionnaires between March and May 2011.

The desire to continue implementation of SLM practices even when payments are not received was also expressed by program participants in focus group discussions. When the benefits of the EPWS program were ranked in order of priority by focus group participants, the payments were ranked the fourth most important benefit of the program, after 1) improved agricultural practices offered, 2) environmental conservation, and 3) exposure to external models of SLM practices. Other benefits were 5) markets for crops and 6) local social capital. Introduction of high value crops such as tomato, cabbage, beans, groundnuts and livestock was mentioned by focus group participants as added incentive for retaining terraces permanently. These crops are a means of increasing household cash income and nutrition.

6.7.4 Cost Effectiveness - Transaction and Opportunity Costs

According to the EPWS key informant, a number of approaches were adopted to ensure services are provided at the lowest possible cost and monitored. One of these is the aggregation of land owners under village authorities to minimise the transaction costs of contracting individual farmers. In addition to the use of village authorities as they are entitled to enter into contracts like EPWS on behalf of farmers who do not have land entitlement, the village authorities were obliged to monitor compliance as they were contract holders. Furthermore, extension services and training through local paraprofessional technical partners in collaboration with EPWS staff were used to minimise transaction costs.

A number of challenges were experienced by the participants and non participants on their ability to participate in the program and adopt SLM practices. According to program participants and non-participants asked on these challenges in the household questionnaire, adoption and implementation of SLM practices were constrained by the delay of payments, lack of manure and insufficient payments (Figure 6.3). Also, key informant interviews and focus group discussions with program participants revealed that PES payments that had been received were not sufficient to cover the costs involved in the adoption of SLM practices. Conversely, incentives such as provision of manure, improved seeds, local and external training and extension services are more important than cash PES payments.

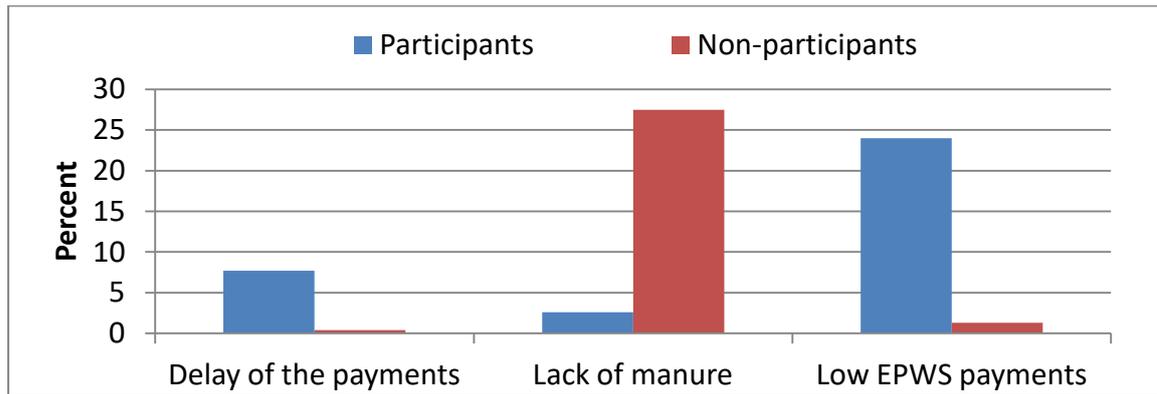


Figure 6.3. The constraints on farmers' participation. Field data collected in household questionnaire between March and May 2011.

Other incentives were more attractive and considered more useful than insufficient PES payments. A key informant in Nyingwa village explained that *“high yields of terrace planted cabbage achieved in 2010 was the result of applying manure, as well as using improved seeds and extension support provided by the EPWS program through extension services”*. Another key informant from Dimilo village explained that *“if I could choose between cash payments and other incentives such as manure, training and extension services, I would choose other incentives”*. In addition, a key informant from Kibungo village explained that *“...if it was not for the training, social networking and that the terraces and trees are for my future benefit, I would quit the program because the cash payments received are insignificant and delayed...like now we have not received the second payments and the people whose farms were measured late have not received their payments”*.

Delay of PES payments and lack of manure were fundamental concerns to program participants and non participants. Some interpreted delay of payments as the act of cheating as payments did not materialize on time as promised by

the intermediary organization staff. Consequently, suspicion over the intermediary organization were built that CARE staff were cheating them. A key informant from Lanzi village explained her concern about the program as *"...my expectation was that this program was not going to cheat on us like children. Several times I have been told the payments are going to be disbursed soon but since my farm was measured seven months ago I have not received any money. I have reached a point of not trusting the EPWS staff"*. Another key informant in Kibungo village who was expecting to spend the payments on manure and a pipe for irrigation explained that *"...although I constructed terraces and planted maize and beans, I am not expecting to harvest anything from this farm as the crops are dying out due to the lack of manure and water. I expected to receive the promised payment to spend on manure and a pipe for irrigation"*.

Low payments and lack of manure were explained as impediment to the adoption of bench terraces and *fanya juu* terraces. During focus group discussions with program participants and non participants, adoption of these practices was considered difficult because for newly constructed terraces to be productive, manure is needed especially during the first few years that the newly constructed terraces begin to gain fertility. This was particularly challenging for the poor and those with small land parcels. A key informant in Dimilo village who was not a program participant but wanted to construct terraces explained that *".....I would like to construct terraces in my farm, but I cannot afford manure which is highly required in the first four years of newly constructed terraces. People with small pieces of land like me would like to construct terraces but it will not be possible"*

without external support to provide materials, especially manure which was only provided once to people who joined earlier”.

6.8 Discussion

The chapter has evaluated the environmental outcomes or the effectiveness of EPWS program in terms of its additionality and leakage effects as well as sustainability and cost effectiveness to provide water service (water quality and quantity) to downstream water users. The evaluation of intermediate outcomes of the intervention that occur earlier, for which information was available and ease of measure helped to overcome time lag challenge involved in evaluating conservation impacts that occur outside the project time frame (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010).

The analysis of the study findings suggests that, while EPWS program is relatively new as it only began in 2008 as a pilot program, already the empirical evidence reveals positive changes in the effectiveness attributes of the program. Estimates of increases in the number of conservation practices implemented by farmers and the size of land under SLM practice suggest additionality of the EPWS program in its potential to supply water services that would not happen without the intervention. This suggests that the changes observed, particularly those that require greatest investment such as bench terraces and agro-forestry, would not have occurred without the EPWS program (Wunder, 2007; Wunder et al., 2008).

The observed high uptake of agro-forestry in the EPWS program is associated with the common practice of planting trees on farms and homesteads in rural Africa (Franzel and Scherr, 2002). Mixing trees with crops such as banana and coffee and planting trees on farm boundaries do not involve a complex operation, unlike terracing, and thus does not limit participation (Pagiola et al., 2008). However, the construction of terraces by some project participants was interesting given their rejection in the 1950s under British colonial authority (Young and Fosbrooke, 1960; Carswell, 2006).

The findings suggest that the programs' spillage effects are more evident than leakages. The findings have demonstrated the adoption of SLM practices among neighbouring non-participants the finding which has been illustrated by Lopa et al., (2012, p.41) that *"farmers who are not part of the scheme have started to copy land interventions, suggesting they are willing to experiment but wish to avoid the formal structures of the scheme"*. The findings have also demonstrated the influence of the EPWS program training on enhancing the enforcement of social norms and by-laws against illegal activities such as fire, illegal logging and forest encroachment. The revealed collective responsibility which involved the reporting of illegal practices is an important noticeable spillage effect of the program. Related finding has been reported by Sommerville et al., (2010) that individuals who changed their environmental degrading behaviour as a result of fear originated from local institutions were less likely to return to the behaviour. This implies that long-term conservation benefits can be achieved with the involvement of local communities and promotion of local governance in managing natural resources (i.e. forest) (Sommerville et al., 2010).

The permanence of the PES program in delivering ecosystem services is a subject of concern because of the temporary nature of payments in many programs (Wunder et al., 2008). If environmental services are externalities, the assumption is that they will only be generated as long as payments are received, thus payments in a PES program should be ongoing rather than finite (Pagiola and Platais, 2007; Pagiola et al., 2007). Otherwise, farmers will revert to previous land uses once payments end as has been observed in other previous conservation approaches that relied on short term payments (Lutz et al., 1994). Contrary to these views, study findings show that SLM practices under EPWS program are inducing long lasting sustainable land use changes and conservation behaviour on the farmers and thus depart from the logic of stopping conservation when payments end. The stated desire of participants to continue implementing SLM practices such as terraces and agro-forestry even without payments suggests the potential temporal scope of PES programs that are implemented in agricultural settings (Tacconi et al., 2011). Once established, SLM practices are privately more profitable to farmers when compared to previous practices and so are likely to be retained (Pagiola et al., 2007). Thus, short term payments, in addition to other non-monetary incentives such as training, manure, seeds, tools (i.e. hoes, machetes and spades) which were highlighted as important by farmers in the context of the EPWS could be sufficient to induce a sustainable change in land use. This suggests that ensuring continued influence of training, manure, and improved seeds, tools (i.e. hoes, machetes and spades) seems more important than payments.

This may not always be the case, however, as Pagiola and Platains (2007) have demonstrated that farmers can be divided into three groups - 'Farmers for whom SLM practices are sufficiently profitable to justify adoption with no additional inducement; second, farmers for whom SLM practices are profitable once established, but for whom initial costs make adoption unattractive; and third, farmers for whom SLM practices are not profitable, even once established. Only for farmers in group two would short-term payments be sufficient to sustainably 'tip the balance'. Farmers in group three may adopt the practices while receiving payments, but would abandon them once payments cease. Farmers in group one would adopt the practices even without payments, so PES would not change their behaviour; at best, it might accelerate changes that would have occurred anyway'.

How short term payments should be used to induce long term effects is another critical question to be considered. For some practices such as agro-forestry and reforestation, short-term payments can be sufficient to sustain them, but long-term payments will often be necessary to enable farmers who implement practices such as terraces to sustainably change their land use choices in ways that support their livelihoods and provide more ecosystem services. Even in the case of farmers for whom short-term payments are satisfactory to induce long-term adoption of SLM practices, longer-term payments may still be desirable because of the conditionality they allow on other land use decisions, such as preventing burning fields or cutting trees in other parts of the farm. Cases in which short-term payments are sufficient are thus likely to be the exception rather than the rule.

As the findings of this chapter have revealed, opportunity costs and transaction costs incurred by the service provider in the adoption of SLM practices constitute fundamental concern for the adoption and implementation of agricultural based PES programs in developing countries. The findings have revealed that, while the participants of EPWS program receive cash payments to cover their transaction and opportunity costs in addition to other non-financial incentives such as training, manure and farm tools, a significant preference was placed on the non-cash incentives over cash-ones. However, while non-cash incentives constitute cash implications, it is likely that the program participants do not take them into account as additional incentives to the received cash incentive.

Other studies have also reported the dissatisfaction of service providers with cash incentives to cover their transaction and opportunity costs and their preference has been for non-cash incentives (Dudley et al., 2007; Kosoy et al., 2008). This could imply that service providers are open to a broader conceptualization of PES and are willing to participate without cash payments. Farmer motivation for participation is inclined towards non-cash incentives which support the acquisition of farm inputs such as manure, hoes, machetes and spades, training and extension services which are expected to enhance participation by poor service providers.

While this may be the case, cash incentives are inevitably important to cover the participants' opportunity costs for the first few years of adoption of improved land management practices (Wunder and Börner, 2011a). Essentially, cash incentives

are necessary to cover the foregone incomes of farmers from the activities they would have undertaken without PES. For example, in the EPWS program, cash payments are intended to cover the opportunity costs of the adoption of SLM practices for the first four years. After this time, the benefits from some of these practices are expected to cover the opportunity costs of participation.

In view of the transaction and opportunity costs of the EPWS program, one can argue that PES programs in agricultural land are expensive and technically complex when compared to forest based PES programs. The main argument here is that, when PES programs require land use modification such as the adoption of new technologies, they tend to be more complex and cost ineffective than when they require farmers to do nothing on contracted land as in forest protection PES programs. Thus, dealing with transaction costs in use-modifying PES programs is much harder than in use-diverting programs (Wunder, 2007; Wunder and Börner, 2011a). High transaction costs in use-modifying PES arise from the costs of organising service providers in prime agricultural areas with higher population densities than in forest margins. In order to reduce transaction costs involved in contracting individual farmers for PES programs implemented on agro-ecosystems, the aggregation of land owners under village authorities is essential. Apart from helping to reduce transaction costs, the approach helps to deal with land tenure issues in places where land rights are under village authorities (Lopa et al., 2012). The use of village authorities to monitor compliance of adopted practices, would thus reduce monitoring costs likely to be commonly encountered in agro-ecosystem PES programs where remote sensing, often considered cheap, is less feasible (Wunder, 2007). Additionally, the use of

local trained paraprofessional technical partners is essential to reduce transaction costs and sustain the provision of extension services to farmers.

6.9 Conclusion

This chapter evaluates the environmental effectiveness of the equitable payments for watershed services (EPWS) program in terms of its additionality and leakage effects as well as sustainability and cost effectiveness to provide water service (water quality and quantity) to downstream water users. Using mixed methods quasi-experimental research design with propensity score matching method, the counterfactual effect of the program from the data collected from both program participants and non-participants was established.

The findings illustrate that the program have had additionality effects, positive leakages and promising sustainability of adopted SLM practices as well as positive measures for cost effectiveness. On additionality, the findings show that, the land under agro-forestry and reforestation practices increased by 6.92% amongst program participants. Also, more program participants use organic fertilizer, practice integrated pest management and plant woodlots. In addition, the program has also resulted in positive leakages such as decreased incidences of forest fire, forest encroachment and illegal logging. On sustainability, the findings show that once established, SLM practices are privately more profitable to farmers and so are likely to be retained after the program has been phased out. The main reason for this is based on the future value expected from the adoption of SLM practices such as increased crop output from constructed

terraces and manure, fire wood and timber products from agro-forestry and afforestation interventions. In this context, PES payments could be a catalyst tool to foster investment in improved and sustainable land-use practices.

The findings of the study suggest that the EPWS program participation has managed to generate additional conservation whereby the percent of land under agro-forestry and reforestation and number of conservation approaches have increased as a result of the program. While the additionality effect of the EPWS program is significant, there is considerable likelihood that the effect could be much higher given the fact that the control group were selected from the same population as the treatment group. This control group might have been affected by the effect of 'neighbourhood', whereby farmers tend to copy technology or acquire information about a particular technology from their neighbours. The comparison of the impacts with program participants/treatment group and non-participants/control group in the same area can potentially underestimate the reported impact of the program in terms of the program additionality.

Chapter 7: Discussion

7.1 Introduction

Payments for Ecosystem Services (PES) are being promoted to support environmental stewardship in agricultural and forest landscapes, and to contribute to poverty reduction in developing countries (Pagiola and Platais, 2007). However, in Sub-Saharan Africa, and Tanzania in particular, limited research has been conducted to understand the effectiveness of PES programs implemented on agro-ecosystems to achieve poverty alleviation and environmental conservation objectives (Ferraro, 2009b; Branca et al., 2011). Also, there is significant lack of rigorous evaluation of conservation instruments that create inferences about unobserved counterfactual outcomes that would have occurred without the intervention due to non-random nature of the design of many of conservation instruments – i.e. PES programs and ICDPs (Ferraro and Simpson., 2002; Ferraro and Pattanayak, 2006; Wunder, 2007; Ferraro, 2009a; Margoluis et al., 2009; Tacconi et al., 2010; Djamhuri, 2012). As such, it is increasingly important to conduct rigorous evaluation studies to understand whether these objectives are achieved.

The data presented in this thesis are specific to the EPWS program implemented in Kibungo ward of Morogoro Region in Tanzania. This case study shed light on the effectiveness of an agro-ecosystem PES program by considering the participation of the poor and factors that affect participation (chapter 4) as well as livelihood outcomes (chapter 5) and conservation outcomes (chapter 6). The use of case study, mixed methods quasi-experimental research with moderately high

external validity, the design permits some generalizability of findings (Vaessen et al., 2007; Margoluis et al., 2009). Therefore, the study extends on the literature that applies rigorous methods to the evaluation of agro-environmental PES programs and conservation instruments in general. This study comes at a time when there are many calls for more rigorous evaluation of conservation instruments that look for what works and what does not to ensure scarce financial resources for conservation are used on what works (Ferraro and Pattanayak, 2006; Ferraro, 2009a; Pattanayak et al., 2010; Miteva et al., 2012).

The findings and arguments presented in the previous three chapters as well as the literature reviews in chapter two are brought together in this chapter. Starting with the methodological reflections, then summary of the findings, the sections after review each of the research objectives set at the start of this thesis. Objectives one, two and three are revisited in respect of the main results, the contribution this has made to the literature, and how these findings have advanced knowledge in this area. Synthesising the results from these three objectives enables discussion of the overall contribution of this thesis, specifically how the formation of farmer groups, labour exchange, formation of trust, information, training of paraprofessionals and non-cash payments are crucial to consider in the design and implementation of PES programs in agro-ecosystems to achieve poverty reduction and conservation objectives. Through this discussion, it is argued that the poor who are eligible can participate in agro-ecosystem PES programs and that their livelihoods and conservation behaviour can change for better than non-participants.

7.2 Methodological Reflections

In achieving research objectives presented in Chapters 4, 5 and 6 successfully, a mixed methods quasi-experimental research design with propensity score matching was used. A household survey, focus group discussions and key informant interviews were used to collect data from the EPWS program participating and non-participating households. The mixed method approach, used throughout the research, permitted flexibility in data collection whilst retaining rigour through triangulation of data sources and gathering of in-depth and rich data. The use of quasi-experimental mixed method research design with propensity score matching permits the following methodological reflections.

Firstly, the integration of concepts from technology adoption, impact evaluation, livelihoods and environmental conservation literature to generate research question, guide data collection and analysis processes facilitated the understanding of the effectiveness of an agro ecosystem PES program. This integrated approach has enabled the understanding of landholders' participation and the determinants of EPWS program participation (Chapter 4), direct and indirect financial and non-financial livelihood outcomes of the EPWS program (Chapter 5) and the environmental effectiveness of the program in terms of additionality, leakage, permanence and cost effectiveness in the supply of water ecosystem services (Chapter 6).

Secondly, the evaluation of intermediate outcomes of the intervention that occur earlier, for which information is available and easier to measure helped to

overcome time lag challenge involved in evaluating conservation impacts that occur outside the program or project time frame (Kapos et al., 2008; Kapos et al., 2009; Kapos et al., 2010). This approach carries forward efforts of devising feasible approaches required for rigorous evaluation of conservation program including PES programs when evaluation of long term impacts is not feasible. The study findings add to the limited literature on the evaluation of intermediate outcomes of PES programs implemented in agro ecosystems in Tanzania and Sub-Saharan Africa in general.

Thirdly, quasi-experimental research design with propensity score matching helped to address attribution challenge involved in the comparison of outcomes of program participants (treatment group) with the outcomes of non-participants (control group) due to the lack of baseline data. Also, the use of propensity score matching helped to address the selection bias challenge between the treatment and control group to facilitate the understanding of the causal effects mechanisms of the treatment on outcomes (Ferraro and Pressey, 2015). In addition, the use of independent – samples *t-test* carried out using SPSS for windows helped to identify the significance of differences between program participants and non-participants on various attributes of environmental and livelihood effectiveness.

Fourthly, the use of mixed methods in chapters 5 and 6 helped to address spatial scale and leakage challenge between the area at which the intervention is implemented and areas where effects or benefits are expected and between the outcomes of treated and non-treated households within the intervention area.

Also, mixed methods enhance deeper understanding of the rigorously generated evidence of the effectiveness of an intervention, by expanding on why and how intervention works or does not work, and under what circumstances in order to inform improvement or revisions. Furthermore, the use of mixed methods approach through sequential integration of quantitative (i.e. a logistic regression model to investigate the significant factors that determine a farmer's decision to participate in the EPWS program) and qualitative methods in chapter four enhanced detailed understanding of the quantitative findings. For example, while the quantitative approach was useful for showing the participation of the poor and factors that determined program participation, qualitative methods enriched these findings by showing why and how the poor have been able to participate in the program.

Fifthly, the use of mixed methods quasi-experimental research design with propensity score matching carries forward the efforts of devising feasible methods required for rigorous evaluation of conservation program including PES programs. Also, the use of quasi-experimental and propensity score matching approach to investigate the livelihood and environmental outcomes of the EPWS program in this thesis has significantly contributed to the understanding of how to implement rigorous, *ex-post*, empirical outcome evaluations of PES conservation programs. The use of rigorous *ex-post* impact evaluation studies are extremely needed to ensure that the limited financial, human, and political resources devoted to conservation programs are put to good use that works (Ferraro and Pattanayak, 2006; Pattanayak et al., 2010; Tacconi et al., 2010; Blackman, 2013; Ferraro and Pressey, 2015). The following sections revisit the objectives and

synthesis of the key findings and explore the implication for agro-ecosystem PES programs.

7.3 Summary of Findings

The thesis consists of three chapters which address three objectives. Chapter 4 shows that the eligible poor households are participating in the program and that household farm size, access to information, perceptions of the participatory nature of the program design and the magnitude of change in required farm management are positive determinants of a farmer's decision to participate in the EPWS program. Although the poor are participating in the EPWS program, their ability to adopt some of SLM practices such as terraces seems to be challenged by initial investment costs such as manure and the opportunity costs of foregone incomes due to the time lag before the systems become productive, particularly during the first few years after constructing terraces. Furthermore, the findings demonstrate that early adopters have influenced their neighbours to adopt SLM practices in the EPWS program.

Chapter 5 shows that the EPWS program has both direct and indirect financial and non-financial impacts on participants compared to non-participants. Also, with regard to poverty and gender equity questions, the study finds that the poor and women have not been made worse in terms of their household's average number of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program. Overall, direct financial payments are the most obvious impact of PES for program participants (Pagiola et al., 2005; Molnar et al., 2008). EPWS conditional

payments ranged between US\$8-US\$48. However, they were considered an important source of cash income to farmers that adopted SLM practices. The programs' indirect financial benefits included increased land value, sources of income, average annual income, and harvests of crops such as maize, beans, bananas and sweet potatoes as well as livestock such as chickens and goats amongst the program participants. Furthermore, for non-financial impacts, the program has resulted in a significant increase in the amount of training and relationships of trust amongst program participants. On the other hand, the findings show that the increase in land value has reduced access to land amongst landless households who used to rent idle land.

Finally, chapter 6 presents the findings on the effectiveness of the EPWS program in terms of its additionality and leakage effects as well as its potential for sustainability and cost effectiveness in the supply of water ecosystem services. The main findings in this chapter are the following. Firstly, the findings on additionality effects of the program show positive and significant change in the behaviour of program participants on the increase in the number of conservation approaches practiced by a household. The program has also increased the proportion of program participants planting woodlot/trees on their farm after EPWS program, and those who use organic fertilizers and practice integrated pest management systems (Table 6.2). Also, program participants have more (7.92%) land under agro-forestry and reforestation practices that could not be achieved without the EPWS program. Secondly, finding on the leakage effects of the program shows considerable decrease in the incidences of fire, encroachment into the forest for agriculture and illegal forest logging in 2011

compared to 2008 before the program began. Thirdly, while PES payments were considered insufficient to cover the costs incurred, the program participants were willing to maintain SLM practices because of the realized and future benefits such as increased crop yields from terracing and future benefits of planting trees such as timber harvests, soil fertility, fire wood and fruits. Fourthly, on cost effectiveness, the use of trained paraprofessionals, and contracting village authorities for aggregated individual land owners and monitoring compliance minimised transaction costs. Also, lack of manure, delayed and insufficient payments constrained program participation and adoption of terraces. Additionally, manure, improved seeds, local and external training and extension services are more important to service providers than cash PES payments.

7.4 Synthesis of Findings across Result Chapters

So far, as shown in the summary of findings (7.2), the findings in Chapter 4 have identified a set of factors that influence participation in the EPWS program. Chapters 5 and 6 report the direct and indirect financial and non-financial livelihood and environmental outcomes of the program respectively. This section integrates the main findings from these three result chapters to discuss the empirical and theoretical contribution of the findings on the participation of the poor and the determinants of participation, as well as livelihood and environmental outcomes of a PES program in agro-ecosystems.

7.4.1 Revisiting Objective one: to examine Participation and the Factors which Determine Participation Decision in the EPWS Program.

Chapter four addressed objective 1 and investigated the participation of households in the EPWS program and the factors that determined program participation. The assessment of whether the poor are participating in PES programs was vital because, in developing countries, the need for PES programs to achieve poverty reduction is one of its vital objectives (Grieg-Gran et al., 2005; Pagiola and Platais, 2005; Porrás et al., 2008). This assessment contributes to empirical evaluations gap that assess the participation of poor households and factors that determine participation decision in PES programs implemented on agricultural land in sub-Saharan Africa and developing countries in general.

The analysis within the chapter built on the results in chapter 4 shows that the relatively poor but eligible households are participating in the EPWS program and their participation has not been limited to the simpler practices such as agro-forestry but they have also been involved in the construction of terraces. However, it is important to note that participation in some PES programs like EPWS program is limited to households that are eligible to participate because payments are made for service provisions or undertaking land use practices that provide services (Pagiola et al., 2005). In the EPWS program, payments were only released after the verification of establishment of agreed SLM practice, meaning that implemented practices formed the basis of payments (Lopa et al., 2012).

Participation of poor in PES programs has been reported elsewhere by Pagiola *et al.* (2010) in a silvopastoral PES program in Colombia where poor households were able to keep up with their wealthier counterparts in terms of program participation. However, there are some empirical findings which contribute to the identification of specific factors that tend to affect program participation and technology adoption decision. One of these is the access to information and technical assistance as demonstrated by EPWS program and other studies elsewhere (Adesina *et al.*, 2000; Adesina and Chianu, 2002; Pattanayak *et al.*, 2003; Zbinden and Lee, 2005). However, access to information was very much linked to the attributes of the program. According to Kosoy *et al.*,(2008), attributes of a PES program are important in influencing farmer's decision to participate. In the EPWS program, public meeting conducted in program villages and local training workshops provided information needed by farmers to make participation decisions.

Another empirical contribution with regard to the understanding of the influence of program attributes in affecting program participation and adoption decision is the program inclusiveness or participation of farmers in the program design phase (Chapter 4). Kosoy *et al.*,(2008) show that farmer participation in program design is an important attribute which can critically determine the extent to which a PES program is voluntary. This is a vital attribute because participation of farmers in the design phase of the program develops their trust and a sense of program ownership (Biggs and Farrington, 1991; Murdoch and Marsden, 1995; Kosoy *et al.*, 2008; Man and Sadiya, 2009; Asmah, 2011).

Further empirical contribution to understanding factors that affect program participation with regard to program attributes is made by the finding that availability and access to technical assistance is vital in program participation decision and adoption of SLM practices. The importance of efficient technical assistance in the adoption of SLM practices is widely recognized (Tacconi et al., 2010; Branca et al., 2011). According to Kosoy *et al.* (2008), successful adoption of SLM practices requires sufficient qualified technical staffs. As demonstrated by the finding in Chapter 5, the availability and access to technical assistance through EPWS program activities was an important ingredient for the adoption of SLM practices. The program built the capacity of local technical staffs through training programs and collaborations between government and non-government institutions working in Kibungo Juu ward through regular meeting. As such, program's technical staffs stationed in the program villages played an important role in providing technical assistance to the farmers and training paraprofessionals were considered relatively more acceptable and accessible locally. These program attributes are vital because program participation and adoption decisions are often preceded by awareness or learning period (Agarwal and Prasad, 1998).

Additional empirical contribution made by the finding is that household land sizes (Chapter 4) affects farmers' program participation decision and their flexibility to adopt some SLM practices introduced in agro-ecosystems PES program. The influence of household land size is widely reported in other studies on program participation and adoption of agricultural technologies (Lasley and Nolan, 1981; Nowak, 1987; Ayuk, 1997; Ur-Rehman and Chisholm, 2007; Yiridoe et al., 2010).

For example, in studies such as Tenge et al.(2005) in Tanzania and Amsalu and De Graaff (2007) in Ethiopia, farm size is identified as a significant factor that influences the adoption of soil and water conservation measures.

Farm size can significantly constrain farmers' flexibility in terms of distributing land into different SLM practices and thus be limited to adopt some practices in agro-ecosystem PES programs. Flexibility is an important advantage that farmers with a large farm (often rich) have over farmers with a small farm (often poor). However, while household land size can significantly determine program participation, land tenure, particularly customary land tenure, prohibits implementation of permanent structures such as construction of terraces and tree planting (i.e. agro forestry, reforestation and afforestation). This means that, there will be some people with large farm sizes who may not be able to participate in some PES programs.

Another vital empirical contribution to the understanding of the factors that can affect participation and adoption of some SLM practices in agro-ecosystem PES program is the importance of farmer groups in assisting adoption of difficult SLM practices. In the EPWS program, the construction of bench terraces and "*fanya juu*" terraces were considered very difficult without extra external labour assistance in some households (Chapter 4). However, through farmer groups formed to encourage work collaborations, members including the poor were able to construct terraces and livestock sheds through labour exchange. Farmer groups are widely acknowledged to enhance technology adoption (Norman et al., 1988; Loevinsohn et al., 1994; Barham and Chitemi, 2009). In Uganda, Kenya

and Ethiopia, farmer groups have enhanced capacity building among farmers, promoted more market-oriented production, improved social assets, increased savings and credit, changed the mindset of extension service providers, influenced rural development, contributed to the national extension policy, increased transparency, and balanced gender participation (Abaru et al., 2006).

More empirical contribution in the understanding of the participation of the poor in agro-ecosystem PES program is that while the poor can participate in the program and construct SLM practices such as bench terraces and “*fanya juu*” terraces, they can be significantly constrained by initial establishment and maintenance costs. Initial establishment costs include costs for inputs like manure and improved seeds, while maintenance costs include costs incurred during the transition phase from conventional agricultural practices to the time adopted SLM practices become profitable. Small payments that are insufficient to cover these costs and conditional payments in which payments are made after verification of implemented practices present major concern regarding the adoption of SLM practices in agro-ecosystem PES program by the poor (Chapter 6). Without adequate economic incentives, poor farmers could encounter temporary negative economic returns which may greatly hinder them from benefiting from SLM practices.

7.4.2 Revisiting Objective Two: to Evaluate the Livelihood Outcomes of the EPWS Program on Program Participants Compared to Non-participants.

Objective two was addressed in chapter five where quasi-experimental and mixed methods research design with propensity score matching methods were used to investigate the direct and indirect livelihood outcomes of the EPWS program. The analysis within the chapter built on the results in chapter five, with the main empirical contribution that - while PES mechanism was not designed for poverty alleviation (Pagiola et al., 2005), evidence from the EPWS program demonstrate positive and significant improvement in the livelihoods of the program participants compared to non-participants. Direct and indirect financial and non-financial outcomes for program participants are more than for non-participants. This is not surprising because, as demonstrated by Pagiola et al., (2005) and Wunder (2005), PES programs generate more benefits to the households that participate. Payments or rewards under PES are conditional on the provision of ecosystem services or undertaking land uses likely to provide ecosystem services (Wunder, 2005; Cole, 2010).

Another empirical contribution made by the finding is on the understanding of the preference of farmers on non-cash payments over cash payments when PES programs are implemented on agro-ecosystem landscapes. Evidence showed that while the received payments constituted an important part of a household's cash earnings, there was significant preference for non-cash incentives such as improved seeds, manure and training which were offered by EPWS program to the participants. However, preference on non-cash payments does not suggest that cash payments were completely not important. In the EPWS program, cash

PES payments were considered an important source of a household's cash income with high degree of spending flexibility. Some recipients of these payments invested their money in productive assets such as chickens and goats and on improving houses, buying clothes, radios, and furniture as well as pay school fees and purchase improved seed.

Cash payments in PES programs are vital because they are easily convertible into local goods and services as prioritized by the receiver (Pagiola et al., 2005; Pagiola et al., 2010). Financial capital is recognised as the most flexible form of capital and is known to reduce household vulnerability through its relatively straightforward conversion into other forms of capital (Ellis, 2000b). It can be invested in both farm and non-farm assets that permit diversification and income generation (Ellis et al., 2003). In studies for the livelihood impacts of PES programs in Cidanau watershed program implemented in West Java, Indonesia (Leimona et al., 2010), Nhambita Community Carbon Project located in Sofala Province, Mozambique (Jindal, 2010), and Regional Integrated Silvopastoral Ecosystem Management Project, implemented at sites in Colombia, Nicaragua and Costa Rica (Rios and Pagiola, 2010), cash PES payments were found to play important role in household transactions. For example, the Mozambique case reports that, although small, PES income in lump-sum enabled investment in things such as land, home improvement, payments of debts and for medical services (Jindal et al., 2010).

Additional empirical contribution of the finding is that intervention activities such as local and external training programs are essential in improving non-monetary

livelihoods of program participants such as capacity building on technical knowledge, social capital enhancement and community visibility. Training course on the variety of SLM practices that the program participants in the EPWS program went through enhanced their awareness of PES and its environmental benefits, land management, governance of local organisations, and business development skills. Furthermore, social capital enhanced through community associations such as farmer networks and farmer groups helped farmers to overcome challenges involved in implementing SLM practices as well as developing priorities and guiding developmental activities in the community. Strong social capital helps to reduce the transaction costs of PES programs and provide other social benefits (Tacconi et al., 2010).

Another contribution of the finding is the understanding that immediate benefits of PES intervention on agro-ecosystem landscape and expected future benefits of undertaking SLM practices such as planting trees for timber, fuel wood and fruits motivated landholders to use their previous idle land. As a consequence, the landless and the small landowners suffer from reduced access to once idle, uncultivated land and marginal lands put into use by the landowners because of promised benefits from PES payments and savings for future generation. This has also been reported by German *et al.* (2010) in the Bushenyi District in Uganda where access to land among the landless was reduced as a result of the expansion of forest carbon sequestration in the Trees for Global Benefits Programme.

Although PES programs are not typically designed with the goal of poverty alleviation, the evidence indicated that EPWS program provided the service providers with many benefits including direct and indirect financial and non financial resources to women and the poor. This study suggests that there is no sufficient evidence that women and the poor will be worse in terms of reducing their household's average number of cash income, share of cash income from different sources and average cash income as a result of their participation in a PES program implemented on agro-ecosystems.

However, the participation and share of outcomes for women is less than for men; the fact which is largely correlated to land ownership (Englert, 2008; García-Amado et al., 2011). Notwithstanding these land ownership facts, findings demonstrate in part that the program has established compensation mechanism that take into account the needs and priorities of marginalized and poor people who are eligible to participate in the program to improve their quality of life and contribute to poverty reduction (Lopa and Mwanjoka, 2010). These efforts need to be enhanced given the important role that women play in rural land-use management such as in water and soil conservation in agriculture and afforestation to improve their access, ownership and control over land.

7.4.3 Revisiting Objective Three: to Evaluate the Effectiveness of the EPWS Program in Terms of its Additionality and Leakage Effects as well as its Potential for Sustainability and Cost Effectiveness in the Supply of Water Ecosystem Services.

Chapter 6 addressed objective 3 and investigated the effectiveness of the EPWS program through intermediate outcomes likely to indicate the potential of the

intervention to increase quantity and quality of water supply downstream. In doing so, quasi-experimental and mixed methods research design with propensity score matching technique was developed to evaluate the effectiveness of the intervention in terms of its additionality and leakage effects, as well as sustainability or permanence of induced behaviour change and the effectiveness of the associated cost (transaction and opportunity costs). This approach helped to overcome attribution problem and other evaluation challenges such as time lag between the intervention and realization of measurable impacts, lack of appropriate baseline data and scale and dynamics of interventions (Ferraro, 2009a; Prowse and Snilstveit, 2010).

The analysis provided empirical evidence regarding the additionality effect of the EPWS intervention. Additionality is one of the key attributes of an effective PES program in delivering ecosystem services (Wunder, 2007) which concern service buyers as they seek to make payments on practices that would not have happened without intervention (2007; 2008). The findings in Chapter 6 suggest that a PES program implemented on agro-ecosystem landscape can ensure delivery of ecosystem services such as improved water quality and quantity service by enhancing the implementation of SLM practices. Evidence in this study shows that compared to non-participants, EPWS program participants have 6.92% higher land under agro-forestry and reforestation practices that would have happened without the program. Also, program participants have undertaken more SLM practices than non-participants. In addition, the program had more spillage outcomes (positive externalities) than leakages (negative externalities) from decreased incidences of fire, forest encroachment and illegal loggings which

are other indicators that the EPWS program is potentially effective in the improvement of water quality and quantity supply downstream.

Another empirical contribution of the finding is that the sustainability of behaviour change or supply of ecosystem services in agro-ecosystem PES program is not exclusively dependent on PES payments. PES literature shows that conditional payments is a fundamental feature of PES programs which affect permanence or sustainability of service provision (Wunder, 2007; Engel et al., 2008; Jack et al., 2008; Tacconi et al., 2010; Tacconi et al., 2011). This feature was employed in the EPWS program, where payments were only released after the verification of establishment of agreed SLM practices (Lopa et al., 2012). Despite this establishment and challenges like delay of payments and low payments identified by program participant, a good number of program participants (73%) expressed willingness to continue the implementation of SLM practices while 62% of non-participants were planning to join the program.

The analysis of the findings suggests that SLM practices for improving quantity and quality of ecosystem services introduced through PES are likely to be permanent or sustainable when behaviour change or land uses desired for service provision by service users are the practices desired by service providers (Wunder, 2007; Pattanayak et al., 2010). In the EPWS program, the construction of terraces was enhancing farm profitability by maintaining soil nutrients on site and increasing crop productivity (Branca et al., 2011; Lopa et al., 2012). Also, practices such as agro forestry, afforestation and reforestation were increasing the water holding capacity of land, while the trees planted under the program are

beneficial (i.e. provide green-manure, fruits, timber, and other non-timber products) to households who are then likely to find it worthwhile maintaining them (Reynolds et al., 2010; Branca et al., 2011; Lopa et al., 2012). Furthermore, as Chapter 5 finding shows, expected benefits from high value crops such as tomatoes, beans, groundnuts and livestock are added incentives for implementing SLM practices even without payments. Benefits that those farmers who joined the program earlier had started to notice through crop production increase, (Chapter 5) are important motivations behind enrolment and likely permanence or sustainability of the implemented SLM practices.

7.5 Scaling-up and Transferability of Findings

An important issue within the evaluation of the effectiveness of an agro ecosystem PES program and within development and conservation community is the transferability and scaling up of lessons learnt from a local case study. Identifying lessons to be learnt from case study research in order to inform the design and implementation of PES conservation initiatives in other agro ecosystem landscapes is vital for conservation and development practitioners in developing countries. This is particularly important for those developing countries with the interest of designing and implementing PES programs in agro ecosystems to achieve poverty alleviation and supply of ecosystem services through SLM practices.

By carrying out evaluation of an effectiveness of an agro ecosystem PES program, it was possible to investigate whether there are generic findings that may have implications for other agro ecosystem landscapes in the region and

beyond. These types of findings can be commonly scaled up from the case study to their larger archetypal livelihood region in Tanzania, sub Saharan Africa and other developing countries, in particular for the design and implementation of PES for people located at the margins of biodiversity rich areas and on steep slope watersheds, whose primary income source is small scale agriculture. Areas like these can be considered as the larger archetypal livelihood region of this study. In many developing countries, agricultural lands managed by the poor (i.e. low-income people) are often located at the margins of biodiversity rich areas and on steep slopes in watersheds (Adams et al., 2004; FAO, 2007b; Bulte et al., 2008; Branca et al., 2011). For example, Nelson and Chomitz (2007) shows that in Honduras and Guatemala, about 70% of areas in 77 most sensitive watersheds explored were inhabited by the poor.

Many of the communities in these landscapes experience almost the same challenges that impede the uptake of SLM practices despite their ecological, social and economic benefits (Liniger et al., 2011). These challenges include knowledge gaps due to the lack of access, and inadequate training of local extension officers (TerrAfrica, 2007) and short term opportunity costs due to negative economic returns associated with the transition phase from conventional agricultural to more sustainable practices with long run economic returns (FAO, 2007a; Liniger et al., 2011). For example, during the transition to new practices such as terraces, yields tend to vary or even decrease significantly as production systems adjust to a new equilibrium (Graff-Zivin and Lipper, 2008; Giller et al., 2009). These costs lead to negative adoption behaviour on the part of poor landholders who may be confronted with higher risk aversion, higher discount

rates and less capacity to make investments (Graff-Zivin and Lipper, 2008). Other challenges are low education levels (Graff-Zivin and Lipper, 2008), access to financial facilities to support up-front investment costs of input costs such as labour and fertilizers or manure (FAO, 2007b; TerrAfrica, 2007) and insecure land tenure that decreases the ability of a landholder to capture the future benefits of making investments in land productivity (Antle and Diagana, 2003).

Given the advantage of quasi-experimental research design with moderately high external validity that permits some generalizability of findings (Vaessen et al., 2007; Margoluis et al., 2009), this section integrates the main findings from the three result chapters to discuss the implication of the findings and lessons that can be learnt for the design and implementation of PES on agro-ecosystem landscapes in developing countries perspective. While the eligible poor have been found to participate in the EPWS program and though their participation is not limited to the simpler practices, one should not jump to the sanguine conclusion that all eligible poor households everywhere will always be able to participate in agro ecosystem PES programs. There may be cases where eligible poor households may find it impossible or difficult to participate as a result of local institutional and specific PES program attributes (Chapter 4) (Kosoy et al., 2008). The analysis of the factors that affect program participation as identified in this study can help to inform the design of agro-ecosystem PES programs to reduce potential impediments to the participation of the eligible poor households.

Ensuring availability and access to information, technical assistance and local and external training programs as well as building community associations such

as farmer networks and farmer groups as demonstrated by EPWS program is vital for enhancing program participation decision, adoption of SLM practices and livelihood as well as environmental benefits. Public meeting conducted in program villages during the program design phase and local training workshops are fundamental mechanism through which to enhance information needs by farmers to make participation decisions as well as to build their trust and feel of program ownership. As the successful adoption of SLM practices require sufficiently qualified technical staff who may be employed by a PES program as technical staffs, training and building the capacity at the local level for paraprofessional is vital for they are considered easily accessible and would ensure permanence of the availability and access to technical knowledge after the program life time given the short life span of many PES programs. Capacity building should be focused on tangible aspects of the specific PES program and problems that put barriers at the local level in implementing PES, particularly lack of right information about the concept of PES and the implementation of different types of SLM practices such as knowledge of where and how to construct different types of terraces and types of trees to plant and their management.

As the analysis of the findings has shown, SLM practices in PES program implemented in agro-ecosystem landscapes may be attractive to farmers, but lack of upfront investment and maintenance costs may be limiting their uptake and up scaling of new practices. As such, upfront investment financing is essential for initial establishment and maintenance costs to farmers who face constraints to capital, and who lack a supply of new required inputs or markets for new outputs (Knowler and Bradshaw, 2007). This suggests that when upfront

investment financing is available and improved SLM practices are very attractive to farmers, where payments could function as a transitory adoption subsidy (Angelsen and Kaimowitz, 2001). Upfront investment financing should consider farmer preferences as some farmers would prefer non-cash payments such as improved seeds and manure over cash payments.

Dealing with transaction costs in use-modifying PES programs is considered much harder than in use-diverting programs (Wunder, 2007; Wunder and Börner, 2011a). High transaction costs in use-modifying PES arise from the costs of organising service providers in prime agricultural areas with higher population densities than in forest margins. In order to reduce transaction costs involved in contracting individual farmers for PES programs implemented on agro-ecosystems, the aggregation of land owners under village authorities is essential. Apart from helping to reduce transaction costs, the approach helps to deal with land tenure issues in places where land rights are under village authorities (Lopa et al., 2012). The use of village authorities to monitor compliance of adopted practices, would thus reduce monitoring costs likely to be commonly encountered in agro-ecosystem PES programs where remote sensing, often considered cheap, is less feasible (Wunder, 2007). Additionally, the use of local trained paraprofessional technical partners is essential to reduce transaction costs and sustain the provision of extension services to farmers.

To ensure permanence and sustainability of behaviour change and supply of ecosystem services in agro-ecosystem PES programs, programs should ensure that SLM practices introduced for service provision are the practices desired by

service providers (Wunder, 2007; Pattanayak et al., 2010). This requires flexibility that provides options to allow landholders to choose from a range of SLM practices which are suitable to their land. For example, the menu of SLM practices offered by EPWS program comprised practices such as terraces (*fanya juu and fanya chini terraces*), grass strips, trash lines, afforestation, contour bunds, riparian reforestation and agro forestry with timber, firewood and fruit trees). Mixing SLM practices, particularly planting multi-purpose tree species ensures that, as the trees mature, farmers can fulfil many of their timber and non-timber requirements such as fodder, firewood and fruits from their farmlands, thus reducing leakage effects that involve forest encroachment.

Chapter 8: Conclusions

8.1 Summary of Contributions

This thesis has examined participation and livelihood and environmental outcomes of an agro ecosystem PES program implemented in Morogoro, Tanzania. The case-study approach has combined mixed methods quasi experimental approach and propensity score matching technique to prioritise rigorous attribution of the livelihood and environmental outcomes of the intervention, which remain under-utilized in evaluation of conservation interventions. Mixed-methods were used throughout the data collection and analysis of the data enabling triangulation of data, and the flexibility that is necessary to understand the effectiveness of a conservation intervention. Therefore, using the case study of the EPWS program in Tanzania, this thesis has provided empirical evidence on the potential of an agro-ecosystem PES program to provide ecosystem services and achieve poverty reduction as well as factors that can affect program participation and adoption of SLM practices.

While assessing the factors that affect program participation and adoption of SLM practices, Chapter 4 highlights that farm size, access to information, participation of farmers in the design phase and the change in farm management required by the program significantly influence the landholder's decision to participate in the EPWS program. Participation of the poor households who are eligible (landholders) and able to participate in the EPWS program are implementing SLM practices and they are not limited to the simple practices but they are also constructing terraces. Farmer groups

formed in association with the EPWS program have facilitated construction of terraces and work collaborations among members. Ideally, the formation of farmer groups along with the implementation of SLM practices through PES is vital to facilitate work collaborations in a more effective way.

Assessing the direct and indirect financial and non financial outcomes of the EPWS program (Chapter 5), this thesis demonstrates that the participants of the EPWS program including the poor and women have not been made worse in terms of their household's average number of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program. It also exhibits that while cash payments to EPWS program participants in return for the adoption of SLM practices are important, indirect financial and non financial outcomes enhanced through program activities such as training programs, supply of manure and improved seeds are also significant. The participants have significant more average annual cash income, more yields from crops such as beans, tomatoes and cabbage, and more livestock like chickens and goats. They also own more consumer durables such as machetes, hoes, radios, mobile phone and spades. In addition, there was significant reduction of their frequency of reducing number of meals eaten in a day, frequency of having to limit portion size at meals times and frequency of skipping entire day without eating, frequency of purchasing food on credit and difficulty in satisfying household food needs. Furthermore, the program participants have significantly received more training and extension services as well as more networks and relationships of trust. Additionally, this thesis shows that

increased value of land translated to higher land rents and reduced availability of land however, which adversely affected the access of land to landless and land-poor households. This clearly requires greater attention during the design of PES programs.

Examining the environmental effectiveness of the EPWS program (Chapter 6), this thesis further illustrates that the program has had additionality effects, positive leakages and promising sustainability of adopted SLM practices as well as positive measures of cost effectiveness. The additionality effects of the EPWS program on the change in the behaviour of program participants include an increase in the number of conservation approaches practiced by a household and increased proportion of program participants planting woodlot/trees on their farm after EPWS, and increased proportion of households using organic fertilizers and practicing integrated pest management systems. Leakage effects of the EPWS program include the significant decrease of the incidences of forest fire, encroachment into the forest for agriculture and illegal forest logging of which there are no significant differences between the perceptions of the program participants and non-participants. On the sustainability or permanence effectiveness of the program, the finding shows that SLM practices are likely to last even after the program has been phased out because of the future value or benefits expected from the adoption of SLM practices such as increased crop output from constructed terraces and manure, fire wood and timber products from agro-forestry and afforestation interventions. Once established, SLM practices are privately more profitable to farmers when compared to previous

practices and so are likely to be retained. With regard to cost effectiveness, the findings show that the EPWS's approach of contracting village authorities to aggregate land owners under their authorities and monitoring compliance reduced costs of contracting individual land owners and monitor compliance. Additionally, the use of local trained paraprofessional technical partners did not only reduce costs of hiring external extension partners, but provided conditions for sustained provision of extension services to farmers even after the program life span.

Based on the findings of this study it can be said that women and poor households that are eligible (landholders) to participate in the EPWS program are participating and implementing SLM practices (Chapter 4). Furthermore, the participants of the EPWS program including the poor and women have not been made worse in most indirect financial and non financial outcomes assessed in this thesis including their household average number of cash income, share of cash income from different sources and average cash income as a result of their participation in the EPWS program (Chapter 5). However, these outcomes should not be interpreted literally without taking into consideration the intervention activities such as training events, provision of extension services, training of paraprofessionals, supply of manure, farm tools i.e. spades, hoe and machetes and improved seeds which enhanced participation and adoption of SLM practices. This implies that the design and implementation of PES programs on agro ecosystems in other contexts similar to that of EPWS program, should take into account the factors that affect participation of the poor households and those that enhances

additionality of program, reduce leakages as well as the factors for sustainability and costs effectiveness. These designs should also consider costs that service buyers and intermediary organization would likely incur such as costs of contracting individual service providers, monitoring compliance and providing extension services.

8.2 Implications

The findings of this study allow identification of a range of measures that could help address challenges that the poor service providers and service buyers or intermediary organization would encounter in designing and implementing PES programs on agricultural ecosystems in poor resource countries like Tanzania. The findings are of particular relevance to the Government of Tanzania's KILIMO KWANZA policy which seeks to address challenges that hinder agriculture (i.e. includes crops, livestock, fisheries, forestry and bee-keeping) development such as poor access and low use of improved seeds and fertilizers, under-investment in productivity enhancing technologies, limited access to financing for uptake of technologies and limited use of available water resources for irrigated agriculture (*Mbunda, 2011*). Linked to *KILIMO KWANZA*, the design and implementation of PES programs in agro ecosystem can be optimized by the following insights from the findings.

Firstly, costs of establishing and maintaining SLM practices in agro ecosystems can be reduced in a number of ways. Aggregating individual landowners under village authorities is an essential mechanism that can

reduce transaction costs involved in contracting individual landowners. Also, costs of monitoring compliance of adopted SLM practices can be reduced when village authorities are contracted. Contracting village authorities is vital because land rights in rural areas where PES programs are likely to be implemented are often under village authorities. Additionally, costs of employing external technical assistants can significantly be reduced by training and using local trained paraprofessional technical partners who can sustain the provision of extension services to farmers after the program life span.

Secondly, the supply of ecosystem services from PES programs implemented in agro ecosystem landscapes is likely to be permanent or sustainable when introduced SLM practices for service provision are the practices desired by service providers. This implies that the design of PES programs for agro ecosystems should allow many options and flexibility that would permit landholders to choose from a range of SLM practices those which are suitable to their land and expectations. Also, the participation of farmers in the design phase of PES programs is essential to ensure the inclusion of their preferences in terms of including SLM practices and non cash rewards of their choice.

Thirdly, because of the future value or benefits expected from the adoption of SLM practices such as increased crop output from constructed terraces and manure, fire wood and timber products from agro-forestry and afforestation interventions, PES payments could be a catalyst tool to foster investment in

improved SLM practices. Thus, short term payments, in addition to other non-monetary incentives such as training, manure, seeds, tools (i.e. hoes, machetes and spades) which were highlighted as important by farmers in the context of the EPWS could be sufficient to induce a sustainable change in land use. This suggests that ensuring continued influence of training, manure, and improved seeds, tools (i.e. hoes, machetes and spades) seems more important than payments.

Fourthly, while cash payments to participants in return for adoption of SLM practices are important, other forms of incentives such as training, supply of manure and improved seeds are also very important. This preference is more pronounced in agro-ecosystems PES (use-modifying) than in PES programs focused on forest land (use-diverting PES programs) where the financial incentives are the key motivation for participation of land owners. Benefits such as increased crop yields; increased value of land; strengthened institutions; increased trust; expanded internal and external networks and increased knowledge of farmers and capacity in farming, leadership and business, are all transferable assets which can underpin activities outside the PES program and thus offer potential to enhance rural development.

Fifthly, acknowledging local informal rules and empowering local communities through local and external training programs to set their own rules which can then guide them to achieve conservation objectives is very important. Informal rules established by farmer groups were useful in guiding their operations to achieve their collective obligations of the program. Also,

the program induced collective responsibility in the community and secret reporting on illegal activities helped to reduce leakages from forest reserve encroachment, illegal logging as well as illegal forest fire and slash and burn agriculture.

8.3 Limitations and Future Research Directions

The findings of the study suggest that the EPWS program participation has managed to generate additional livelihood and conservation outcomes that would not have happened without the intervention. While the additionality effect of the EPWS program is significant, there is considerable likelihood that the effect could be much higher given the fact that the control group was selected from the same population as the treatment group. This control group might have been affected by the effect of 'neighbourhood', whereby farmers tend to copy technology or acquire information about a particular technology from their neighbours. The comparison of the impacts with program participants/treatment group and non-participants/control group in the same area can potentially underestimate the reported impact of the program in terms of the program additionality.

Because of the short term nature of the EPWS program, there is a need to conduct another research after at-least five or ten years to assess the long term sustainability of the land use changes introduced by the program. Data should be collected from both program participants and non-participants to measure subsequent changes to land use. Also, it should examine the extent to which land uses introduced during the program life have been retained

or/and further expanded by program participants or/and adopted by non-participants. In addition, it should examine what practices experienced continued expansion to whom and why? This study will be very useful to address the main PES concern related to short term payments that gains from PES payments would be lost once the program ended.

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