Assessment of the Central American Cocoa Project in Costa Rica: Did livelihoods of project participants improve?

M.Sc. Thesis

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In memory of an excellent father Carlos Leon Perez. Let me finish this journey with the same word we began: I love you.
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List of Abbreviations

ACOMUITA  Commission Association of Indigenous Women of Talamanca
APPTA  Producers Association of Talamanca
CATIE  Tropical Agricultural Research and Higher Education Center
COAS  Cooperatives and Associations
DFID  Department for International Development
PCC  Central America Cocoa Project
MAP  Mesoamerican Agro-environmental Program
ICCO  International Cocoa Organization
INEC  National Institute for Statistics and Census
IUCN  International Union for Conservation of Nature
UNDP  United Nations Development Programmed
WCF  World Cocoa Foundation
Abstract
Using the livelihood framework, an assessment of the Central American Cocoa Project was performed to evaluate assets endowment and livelihood changes for households’ participants in Talamanca, Costa Rica. The project was implemented with the objective of having an impact on productivity, competitiveness and environmental service provision for the cocoa sector in Central America. A comparison of the situations encountered in the baseline (2008) against the last survey applied (2012) was conducted using an adequacy assessment method, due to the absence of control groups and the allowance of secondary data. Analysis was made according to livelihood framework by characterizing, comparing and describing changes in four aspects: a) asset endowment b) livelihood strategies c) natural resources based activities and d) effects on livelihood security and environmental sustainability. Data was sampled from 101 households for 2008 and 100 households for 2012 that were randomly selected from two of the main cocoa organizations in Talamanca (Producers Association of Talamanca and The Commission Association of Indigenous Women of Talamanca). Based on the rural poverty lines for 2008 and 2012, published by Costa Rican Institute for Statistics and Census, households were categorized into three income-wealth groups: extreme poor, poor, non-poor. The majority of household participants (>90%) are either extreme poor or poor. Three livelihoods were recognized: households that generate more than 70% of its total annual revenue from cocoa, households that generate more than 70% of its total annual revenue from off-farm activities, and households that generate their annual revenue from diversified strategies without a specific fixed percent contributing to revenue. Extreme poor participants rely mainly on cocoa production as main income source. Natural resource based activities are the main contributor to total revenue. Results show that technical assistance, number and area of farms, number of tree species, and adoption of new agroforestry systems use for shade, show statically significant increments. Insignificant statistical differences are found for percentage weight of cocoa in total revenue and total agricultural revenue. A statistically significant relationship between the livelihood strategies and income groups is found. On the other hand, cocoa volume of production and commercialization show significant statistical lower values. Faulty agricultural practices, unfavorable climatic conditions and diseases affected cocoa production and production limitations were perceived. Future interventions should pay attention to human capital; extension and technical assistance on crop management techniques could enable greater productivity.
1 Introduction

1.1 Problem statement

Cocoa (*Theobroma cacao* L.) serves as an important crop around the world: a cash crop for producer countries and a key import commodity for processing and consuming countries (WCF, 2012). Ninety percent of cocoa is produced by smallholders (Hütz and Fountain, 2012). World Cocoa Foundation (2012) estimates that 40-50 million people depend on cocoa for their livelihood. Latin America, West Africa and Indonesia are the main cocoa producing regions (Franzen and Mulder, 2007).

In Mesoamerica, approximately 80,000 small farmers grow cocoa on approximately 100,000 hectares (WCF, 2010). Annual production for Mesoamerica amounts to 6,000 metric tons per year with a gross value of approximately $7 million USD per year (CATIE, 2010). Most of cocoa farming is produced by poor indigenous and Afro-Caribbean farmers living and working in remote areas and often around protected areas of national and international interest.

Over the years, Talamanca (Costa Rica) has launched development and extension programs that promote cocoa agroforestry systems in indigenous territories. These programs have been promoted by organizations such as The Nature Conservancy, the Tropical Agricultural Research and Higher Education Center (CATIE), and the University of Costa Rica (Winowiecki, 2008). Between 1989 and 2001, CATIE carried out different projects aiming to establish systems for the generation and transfer of agroforestry technologies through sustainable management of natural ecosystems and promoting rural development (Avila, 2010). Over the last 20 years, eight cooperatives and associations (COAs) have been formed. COAs directly involve 5,866 partner families who cultivate 7,996 hectares and annually produce 1,515 tons of certified and conventional cocoa (PCC, 2007).

The Central America Cocoa Project (PCC) was launched in January 2008 as part of the Mesoamerican Agro-environmental Program (MAP). The PCC is a cooperation platform for technological innovation, dissemination and application of knowledge, which was designed and operated jointly by CATIE, cocoa farming families, their COAs, and other partners. The PCC sought to raise the competitiveness of cocoa farms, improve business
operations with COAs, provide environmental services to the society and stimulate and upgrade other players in the cocoa sector in Central America (PCC, 2008).

These projects aim to achieve sustainable production of cocoa, which is a valuable alternative to help families out of poverty and to maintain healthy ecosystems. Sustainable cocoa production refers to a system that respects the balance of the ecosystems taking into account the management of agrochemicals, biodiversity conservation practices, soil and water (PCC, 2008). However little is known about the effects of these projects in the assets endowment and livelihood strategies at cocoa household level in Talamanca.

1.2 Main objectives

The present study analyses the livelihoods of farmers who are part of the PCC in Costa Rica, using cocoa producing households of Talamanca as an example.

The aim of the present thesis is to compare and describe the asset endowment and livelihood strategies for project participants in Talamanca, Costa Rica between 2008 and 2012, supporting changes observed at the cocoa household level. The analysis will be carried out using the livelihood approach framework as the main guide. In this context, the objectives of the study are:

1. Characterize the changes in asset endowment of project participants between 2008 and 2012.

2. Determine the changes of cocoa household livelihood strategies between 2008 and 2012.

Based on the literature, case studies and the objectives established, this study intends to address the following research questions:

a. What are the livelihood strategies of cocoa households?

b. What is the assets endowment (human, social, natural and physical) of cocoa households participating in PCC? Were there major changes since 2008?

c. What is the percentage weight of cocoa production in total household revenue? Are there changes compared to 2008?
d. What is the role of cocoa production within the household livelihood strategy?

e. Did the adoption of different agroforestry systems for cocoa shade increase from 2008 to 2012?

The study is divided in seven chapters. Chapter 2 gives an overview of the Central America Cocoa Project. Chapter 3 explains the framework for a micro policy analysis of rural livelihoods. Chapter 4 explains the impact assessment methods, collection of data, analysis of information and the variables selected for the study. Chapters 5 presents results with a discussion regarding asset endowment, livelihood strategies, and natural resource based activities and its effects on livelihood security and environmental sustainability. Main conclusions derived from the study are found in chapter 6. Chapter 7 provides references used in the thesis.

2 The Central American Cocoa Project

2.1 Cocoa production in Latin America and Costa Rica

In Latin America Brazil is the leader in total production of cocoa with 4.1% of global cocoa production, followed by Ecuador ranking seventh with 3.1% of global production, and the Dominican Republic with 1.9% (ICCO, 2012). For the year 2013, ICCO projected the following growth rates for the main Latin American cocoa producing countries: 19% for Ecuador and 10% for Brazil and the Dominican Republic.

The region has demonstrated a growth potential in production, emphasizing organic cocoa. The region produces 70% of the worldwide organic cocoa compared to the conventional 13% mainly dominated by African producers. The Dominican Republic is the leading organic cocoa supplier in Latin America with 5,000 metric tons for the harvest of 2009/2010 (Nadurille, 2010).

Central America cocoa production represents less than 0.1% of world production. However it is of great economic importance to more than 15,000 families living in remote and difficult to access areas (PCC 2007). For these families, cocoa is one of the few sources of cash income because it is non-perishable and easy to transport to retail outlets.

Even though prices have risen in recent years, there are several limitations for cocoa producers in Central America that specialists constantly highlight: access to credit, limited infrastructure and lack of technical knowledge of the crop.
Costa Rica ranked as the 39th largest producer of cocoa with 665 metric tons in 2012. Its cocoa is known to be fine and flavored, characteristics that have opened a market for high quality organic cocoa. The European market tends toward environmental and socially responsible high-quality chocolate, resulting in an important opportunity for Costa Rica to market its cocoa.

In the 1980s, the growth of a disease known as “moniliasis” triggered the introduction of unproductive hybrids leading to a persistence of low prices that ultimately resulted in total crop area being reduced to 3,601 hectares by 2007 (BCIE, 2010).

Currently, about a quarter of the planted acres are reportedly abandoned. In Costa Rica, cocoa farming occurs in three regions: the Atlantic, North and Central Pacific Huetar. In 2007, it was estimated that 81% of the area under cultivation was within the Atlantic region. The Talamanca district contains 2,740 of the country’s 3,601 hectares dedicated to this crop. Figure 2 indicates the cocoa producing regions in Costa Rica.

**Figure 1. Costa Rica cocoa producing regions, 2010**

Small and medium farmers represent the majority of cocoa producers in Costa Rica. Among the 2,229 small and medium farmers in Costa Rica in 2010, 1,700 producers belonged to Talamanca; most of them members of producers associations and cooperatives such as APPTA and ACOMUITA.
2.2 Origins of the PCC

An example of micro policy as an economic instrument is the case of PCC, a project that seeks poverty reduction through the adoption of different cocoa systems, promoting the use of cocoa with other crops, different species of trees or major and minor species as a livelihood strategy.

The project originated in 2004 as an initiative of CATIE (Tropical Agricultural Research and Higher Education Center) for the Norwegian Program for Sustainable Use of Natural Resources in Central America, aiming to support more than 6,000 families and other stakeholders of the cocoa sector in Central America, as part of the Mesoamerican agro-environmental Program (MAP). The project objective was to improve sustainable agroforestry production farms and to contribute to environmental conservation (CATIE, 2008).

MAP is a key initiative of CATIE to collaboratively, with partners and donors, implement methodologies to support the development, communication and knowledge management of cocoa production and conservation in Mesoamerica (CATIE, 2008).

In 2007, before the PCC started to operate, cocoa cultivation in Central America occupied between 23,000 and 25,000 hectares in the hands of some 18,000 indigenous and rural poor families living around protected areas of national and international interest. Among these protected areas are the Atlantic Mesoamerican Biological Corridor, conservation priority areas of the International Union for Conservation of Nature (IUCN) and The Nature Conservancy (TNC) in Mesoamerica. Figure 3 shows the Indigenous communities where the PCC intervened, as well as the locations of the main conservation areas in Central America. Rectangles in red show the areas where the PCC intervened in Costa Rica.
2.3 Objectives and achievements of the PCC

The aim of the project is to strengthen the eight main cocoa associations and cooperatives (COAs) in Central America, by focusing on reducing poverty and increasing competitiveness among these associations.

The project intended to assist and improve the conditions of the Central American cocoa sector by jointly implementing funds with the main COAs of each country in a partnership of more than a hundred local and international members. The purpose was to get a thousand families per country to join with COAs and schools to increase their capacities and work to increase the competitiveness and the provision of environmental services in the cocoa sector for the countries that were part of the initiative (PCC, 2007).

According to PCC, (2009) some of the project’s achievements include:

a. Establishment of clonal gardens of superior cocoa germplasm and distribution of seeds and plants.

b. Six of the ten COAs of the PCC account for and track business strengthening plans; and two COAs include business assessments.
c. Education of families through the implementation of field school programs, developing methodology for introductory issues, reproductive biology and vegetative propagation of cocoa.

2.4 PCC partners in Talamanca region

In Costa Rica, the project is managed through an agreement with two of the main associations of the Talamanca region (Avila, 2010):

- **ACOMUITA (Commission Association of Indigenous Women of Talamanca):**
  It counts among its members at least ten women's organizations representing the biggest ethnic groups in the region, Cabécares and Bribris. They hold positions in almost all indigenous projects. It is the oldest women's organization in the cocoa sector in Central America.

- **APPTA (Producers Association of Talamanca):** Association of small producers founded in 1987, with 30 years of working in Talamanca. Composed by 1,093 small producers of which 38% are women; 80% of its members are indigenous Bribris or Cabécar. The association is dedicated to the marketing of organic cocoa, organic bananas and other fruits.

  APPTA has 68 associates that provide funding (through a micro-credit revolving fund), purchase, selection and processing of dry cocoa products (cocoa powder and chocolate candy balls). From conjunction with other organizations, it has led the involvement of industrial processing of cocoa and ethnic agro-tourism.

  APPTA, faithfully attached to their social and environmental principles, enjoys wide recognition among various agencies and institutions of national and international cooperation. It has promoted the agro-ecological production model, accompanied by a capacity development based social enterprise. Its production is certified organic and fair trade. APPTA is commercially diversified, since it produces crops such as cocoa, banana and plantain. It has exported organic cocoa in the past.
3 Theoretical Framework: Livelihood Framework

The methodological process of this study was based on the livelihood framework, a tool focusing on people-development for a better understanding of the livelihoods with specific emphasis on the poor.

Different definitions are given to the term livelihood. For this study we use Ellis (2000) definition: A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household.

The livelihood framework has had a substantial influence on rural development policies; this framework emerged in the mid-nineties as an integrated people-centered approach focusing on research and policy making (Cameron, 2005). According to the Department for International Development (DFID) (1999), the livelihood approach “seeks to gain an accurate and realistic understanding of people’s strengths (assets or capital endowments) and how they endeavor to convert these into positive livelihood outcomes. The livelihood approach believes that people require a range of assets to achieve positive livelihood outcomes; no single category of assets on its own is sufficient to yield all the many and varied livelihood outcomes that people seek” (DFID, 1999).

A systematic analysis of livelihoods takes into account the multiple dimensions of rural poverty, while paying special attention to the vision of the producer. A strict definition of livelihood does not only refer to income, it also considers the gender, social relations and property rights to sustain the subsistence strategies adopted by a household.

As Ellis explains, “social and kinship networks are key drivers that facilitate and sustain diverse income portfolios”. (Ellis, 1998). Figure 3 show the conceptual framework used in this study.
**Figure 3. A framework for micro policy analysis of rural livelihood**

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<th>D</th>
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<tr>
<td><strong>Livelihood Platform</strong></td>
<td><strong>Access Modified</strong></td>
<td><strong>In Context of</strong></td>
<td><strong>Resulting in</strong></td>
<td><strong>Composed of</strong></td>
<td><strong>With Effects</strong></td>
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<td>Social relations</td>
<td>Gender</td>
<td>Trends</td>
<td>NR-based activities</td>
<td>Livelihood security</td>
<td>Income level</td>
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<td></td>
<td>Class</td>
<td>Population</td>
<td>Cultivation (food)</td>
<td>Income stability</td>
<td>Seasonality</td>
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<td></td>
<td>Age</td>
<td>Migration</td>
<td>Cultivation (non-food)</td>
<td>Degree of risk</td>
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<td>Ethnicity</td>
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<td>Assets</td>
<td>Natural Capital</td>
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<td>Livelihood Strategies</td>
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<td>Physical Capital</td>
<td>Drought</td>
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<td>Human Capital</td>
<td>Flood</td>
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<td>Diseases</td>
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<td>Civil War</td>
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<td>Institutions</td>
<td>Rules and Customs</td>
<td>Organisations</td>
<td>Associations</td>
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<td>Land tenure</td>
<td>NGOs</td>
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<td></td>
<td>Markets in practice</td>
<td>State Agencies</td>
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</table>

Source: Ellis (2000).

According to Ellis, the framework is a useful guide for poverty reduction in micro policies: interventions that have an effect on the livelihood options and strategies at the local levels (Ellis, F., 2000).

Ellis explains that it is the rural household that represents the main social unit to which the framework can be applied. The framework points out that at the village or community level, the households will have more than one livelihood strategy. Livelihood will change through time in response to internal and external stimuli (Chimhowu and Hulme, 2006).

“Household” for this study is understood as, according to Ellis’ definition, “a social group that resides in the same place, shares the same meals, and makes joint or coordinated decisions over resource allocation and income pooling” (Ellis, 2000). The literature describes households as “multipurpose units” that contain multiple social identities.

Other definitions give a similar understanding to the concept of household; Messer describes the household as: “…that group of people, their relationships and activities, who acknowledge a common authority in domestic matters, a budget unit, or a group who have a common fund of material and human resources and rules and practices for exchange within it” (Messer, 1990).

Over time, economists have found it convenient to treat the household as a single decision making unit, relying on the decisions of the head of the household.
3.1 Assets

Capital assets are resources that can be used directly or indirectly to generate sources of subsistence for households, contributing to the alleviation of poverty (Carney et al., 1999, and Ellis, 2000).

The livelihood framework has five different types of capitals or assets: human capital (skills, education, health), physical capital (produced investment goods), financial capital (money, savings, loan access), natural capital (land, water, trees, etc.), and social capital (networks and associations). These assets represent a tool to challenge or convert the rules that govern the use and transformation of the resources.

As Ellis explains: “A fundamental feature of assets as stocks of capital is that they either exist as a stock (e.g. land or trees) giving rise to a flow of output, or they are brought into being when a surplus is generated between production and consumption, thus enabling an investment in future productive capacity to be made” (Ellis, F., 2000). At the same time Ellis points out that how the assets are categorized are certainly a little contrived: “…and not all resources that people draw upon in constructing livelihoods fit neatly within them. Nevertheless, they serve a useful purpose in distinguishing asset types that tend to have differing connections to the policy environment” (Ellis, 2003).

The prominence of assets, how these are used through time, social factors, shocks or exogenous situations, can change the livelihood strategies of a population. Table 1 explains the five assets types.
Table 1. Type of livelihood assets.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Description</th>
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<tbody>
<tr>
<td>Social</td>
<td>The way in which people work together, both within the household and in the wider community. In many populations different households will be linked together by ties of social obligation, reciprocal exchange, trust and mutual support represented by membership or more formalized groups.</td>
</tr>
<tr>
<td>Financial</td>
<td>The financial assets available to rural households may come from the conversion of their production into cash in order to cover periods when production is less to invest in other activities. They may make use of formal and informal credit to supplement their own financial resources.</td>
</tr>
<tr>
<td>Natural</td>
<td>Refers to the natural resource stock from which resource flows and services important to livelihoods are derived. For people living in rural areas it includes assets, such as land, water, forest resources and livestock, which are of key importance for the production of food and income. The ways in which people have access to these resources, ownership, rental, common pool, etc., need to be considered as well as the condition of the resources themselves, their productivity, and how they may be changing over time.</td>
</tr>
<tr>
<td>Human</td>
<td>People’s health and ability to work, and the knowledge and skills they have acquired over generations of experience and observation, constitute their human capital. Education can help to improve people’s capacity to use existing assets better and create new assets and opportunities.</td>
</tr>
<tr>
<td>Physical</td>
<td>Refers to basic equipment as basic infrastructure and producer goods needed to support livelihoods. ‘Basic Infrastructure’ refers to physical environment that helps people meet their basic needs and to be more productive in livelihoods. Producer good refers to productive capital improving income and consumption for the households. This asset will influence people’s ability to earn an adequate livelihood.</td>
</tr>
</tbody>
</table>

Source: Adapted from Messer and Townsley (2003)

The five assets explain above define the context which influences the opportunities available, and restrictions on households in pursuit of their livelihoods.

The five capital assets of the livelihood framework, as Rakodi explains, place a reality of the households as the center of analysis and policy, “without ignoring the contextual economic, political and social factors which determine their ability to construct sustainable livelihood strategies. It provides a more adequate multi-dimensional understanding of poverty, impoverishment and increased well-being than analysis of income or consumption alone, in both urban and rural areas” (Rakodi, 1999) . Until now there are no exact steps
for an analysis that focuses on or explains which of the five assets must be strengthened first and for whom.

### 3.2 Livelihood strategies

The concept of a livelihood strategy for this study is understood as a portfolio of activities with selections that people make to achieve their livelihood goals, including productive activities, investment strategies, reproductive choices (Jansen et al., 2006).

As explained in Figure 1, livelihood strategies are comprised of activities that reveal how households survive. There are two types of activities in the framework of micro policy analysis of rural livelihood: natural resource and non-natural resource based activities. In Figure 1, each type of activity is described, which symbolize a permanent contribution to the survival portfolio of the households.

For the purpose of this study, focus will be given to the first group, natural resource based activities, explained as: “collection or gathering (e.g. from woodlands and forest), food cultivation, non-food cultivation, livestock keeping and pastoralism, and non-farm activities such as brick making, weaving, thatching and so on” (Ellis, 2000). Scoones (1998) recognizes three 'broad clusters' of livelihood strategies, as explained in Table 2.

**Table 2. Livelihood strategies**

<table>
<thead>
<tr>
<th>Livelihood Strategy</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.Intensification or extensification</td>
<td>Focus on increasing dependence on agriculture as the strategy, through intensification of different resources such as: labor or capital for a specific quantity of land. If households choose this strategy depends on the potential agro climatic situation in relation to the possible implications for labor and capital.</td>
</tr>
<tr>
<td>2.Livelihood diversification</td>
<td>Appealing in a variety of non-agricultural or non-natural resource based activities through, for example, off-farm income earning. “Rural livelihood diversification is defined as the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living” (Ellis,2000)</td>
</tr>
<tr>
<td>3. Migration</td>
<td>It refers specially to remittances as the main strategy adopted by the household. Authors describe it as voluntary and involuntary action by members of the household.</td>
</tr>
</tbody>
</table>


Scoones (1998) explains that a key part of livelihood analysis is unveiling the different combinations of livelihood strategies and assets endowment.
3.3 Livelihood framework in cocoa production systems

Different studies have used the livelihood framework to analyze the relationship of cocoa and their livelihoods. In the Talamanca region of Costa Rica, Dahlquist et al. (2007) analyzed and compare different agroforestry systems of cocoa with different tree species and crops. They concluded that achieving higher cocoa yields and improving cocoa farming aimed to reduce the incidence of pests and diseases through technical assistance and support from local institutions.

Martinez et al. (2007) analyzed the livelihood strategies of households producing organic cocoa in the state of Tabasco, Mexico. The authors found that the diversification of sources of income and crops was a key strategy to reduce vulnerability.

Laird et al. (2007) found that biological and cultural diversity plays an important role in the livelihoods of five indigenous communities producing cocoa in Cameroon.

4 Methodology

Methodology is divided into three parts. The first part makes a description of the three impact assessment methods: adequacy, plausibility and probability assessments, and explains the method selected for this study. The second part discusses Talamanca, the location for the study. It describes the districts geography, climate conditions and actual socio-economic characteristics. The third part describes how information was gathered and processed.

4.1 Impact assessment methods

According to Habicht et al. (1999) three different choices exist for evaluating an intervention: adequacy, plausibility and probability assessments. Each type of assessment is determined by the kind of inference being made as well as the degree of confidence that observed changes are a result of a particular project.

The adequacy assessment makes a comparison between the fixed goals and the program’s performance, aiming to demonstrate if the program or project is adequate to meet the goals. In this type of assessment, a control group is not required, as Bohensky and Lynam (2005) explain that the standard of the assessment is the outcome of the project compared with the goals of the project.
Carletto and Morris (1999) indicate that the adequacy assessment tends to be of little use for evaluations since it is unable to isolate the effects of the project from those of other concurrent processes. Other authors point out the inability of this assessment to make statements with regard to causality or attribution. On the other hand, adequacy assessments can quantify change over time without attempting to account for secular change. It is also the less expensive assessment of the three types. Habicht et al. (1999) explain that assessing change over time requires at least two measurements. An adequacy assessment has the advantage of working with secondary data as a way of lowering the costs of the evaluation. An adequacy evaluation can reassure that expected goals were met leading to potential continual support to a project.

The plausibility assessment is a different method to assess impact. It compares changes of a non-random selected group aiming to quantify effects of secular change (Pronyk et al., 2012).

Habicht et al. (1999) explain that a plausibility assessment attempts to control for the influence of confounding factors by previously selecting control groups before the evaluation has begun, or afterwards throughout the data analysis.

Carletto and Morris (1999) explain the necessity for controlling this confound arises from the fact that over the project life cycle, it is likely that external factors may contribute, positively or negatively, to changes in outcomes measured among project participants.

It is essential for plausibility assessments to have a control group. According to literature, the control groups most show identical characteristics to the beneficiary group except for the participation in the project. For this assessment, controlling confounding factors is imperative as is controlling for group heterogeneity as conditions for conducting a proper evaluation.

Habicht et al. (1999) explains that according to the objectives established and the constraints dictated by the specific conditions, evaluators can select three different types of control groups:

1. Historical: same target institutions or population.
2. Internal: institutions, geographical areas or individuals that should have received the full intervention but did not; either because they could not or refused to be reached by the program.

3. External: One or more institutions or geographical areas without the program.

Using control groups allows for more plausible conclusions than if no control groups were utilized. Evaluators should take control in this assessment due to the existence of control groups. Habicht et al. (1999) explained that it in relation to its name a plausibility statement is founded on value judgments of experts in a field which includes decision makers and evaluators.

From an academic perspective, Habicht et al. (1999) points out that a limitation of the plausibility assessment is that one cannot fully rule out all alternative explanations from the observed differences, while from a practical and programmatic point of view, even the less stringent plausibility statements are at times sufficient to determine a future for a program.

The third outcome in a probability assessment makes sure that there is a minimize and a known probability that differences between a project and control areas were due to confounding, to a systematic bias, or to chance (Carletto and Morris, 1999). This outcome statement is founded on a random allocation to project intervention or control status, permitting one to define with a given probability that the average features of the intervention and control groups are identical.

As Habicht et al. (1999) depicts, the randomization does not assure that all confounds are excluded; rather, it assures that the probability of confounding is measurable. Randomization may seem discouraging, but in most circumstances, as Carletto and Morris (1999) explain, it is relatively straightforward. In addition to randomization, a probability statement will require adequate statistical power; deprived of this condition, this assessment becomes a plausibility statement.

For the matter of this study, an adequacy assessment was chosen, since there was no existence of a treatment and control groups in the region where data collection took place. An adequacy assessment does not require control groups and permits analysis of secondary data for two different time periods. With the election of this impact assessment method, the study intends to compare the goals fixed by PCC against the outcomes with regards to
livelihood and assets endowment for project participants for the years 2008 and 2012 in Talamanca, Costa Rica.

4.2 Location of the study

Research was conducted in the rural district of Talamanca, located in the Limon province. Figure 4 shows the location of the study in Costa Rica. The PCC chose this area to be part of the project because it’s the biggest cocoa producing region in Costa Rica, comprising of 1,700 cocoa farmers.

The indigenous territories of Talamanca are located on the Atlantic south of Costa Rica, near the border with Panama. The total extension of this indigenous district is 2,809.93 km², divided in two main areas, Upper and Lower Talamanca. Administratively, it is divided into three districts: Bratsi, with 2,399.51 km²; Sixaola, with 237.01 km² and, Cahuita, with 173.41 km². This is the farthest region from the Atlantic Zone (Aruanda, 2010).

The prevailing climate condition in Talamanca is humid and tropical with average temperatures ranging from 24-30°C in coastal areas; at higher altitudes the climate is tropical rain, with temperatures descending to 11°C in the glacial moors of the mountain range, where altitudes reach over 3,000 meters.

This wealth of natural habitat in the area has contributed to the territories forming part of the Amistad Caribbean Conservation Area, the Mesoamerican Biological Corridor (MBC), the Biosphere Reserve of Friendship (RBA) and Talamanca Caribbean Biological Corridor (Avila, 2010). Almost 50% of the territories in Talamanca are protected zones.
The population of Talamanca consists of approximately 34,008 inhabitants (43% women). It has one of the lowest Human Development Indexes in the country (0.611), just above Alajuelita (0.596). According to this index, the social gap is ranked 81 out of 81 positions. The illiteracy rate is 16.3%, versus the national rate of 6.9%; the infant mortality rate is 23.9, versus 10.9 for the rest of the country (UNDP, 2011).

The main economic activities are related to agricultural production. Activities of farmers in Talamanca are in the following order: Cattle have 6,295 hectares representing 44% of agricultural activity, followed by 3,205 hectares for plantain production which represents 22.53%. Banana represents 14.46% with 2,058 hectares, cocoa with 1,800 hectares represents 12.65%, banana native species represent 5.54%, Palm production represents 0.51%, leaving tropical roots last at 0.07% (Aruanda, 2010).

The main indigenous ethnic groups of Talamanca, the Bribri and Cabecar, collectively represent respectively 35.6% and 36.5% of the indigenous inhabitants of Costa Rica, totaling 72% of this population.
4.3 Data collection

4.3.1 Secondary information

The compilation of secondary data was performed by reviewing literature in books, journals, gray literature (seminars, project reports, baseline studies), results of livelihoods studies conducted by the PCC, and other documentation on economic and financial aspects of cocoa farming, historical records of prices in domestic and international markets, the provision of livelihood assets and their interrelationships, the institutional environment, policies, and regulations, among others.

4.3.2 Use of baseline survey (2008) and final survey (2012)

The PCC conducted semi-structured interviews to household’s heads about the five capitals (human, social, physical, financial and natural), vulnerability context, perceptions of their productive activities and changes in farm practices. To carry out the collection of data, the PCC collaborated with local teams and Master’s students at CATIE (PCC, 2008). In addition, the PCC staff performed direct observations by means of farm tours, dialogue with key informants and marketers involved with Costa Rican cocoa producing organizations.

Before the survey was applied, PCC members pre-tested the questionnaire with a group of producers in the research area to adjust the questionnaire and avoid missing questions. The tool was applied to the household heads in conjunction with household members (spouses, children, etc.). Members to which the questionnaire was applied were previously chosen randomly from lists of APPTA and ACOMUITA.

This study uses the dataset generated by CATIE of 101 project participants who initiated the PCC in 2008 when the baseline was carried out in Talamanca. Some of these beneficiaries left the project from 2008 to 2011, due to migration to other cities, death, or total abandonment of cocoa production. Additionally, the 2012 dataset was compiled by the surveys taken by CATIE on a new sample of 100 cocoa farmers. Since the two groups (2008 and 2012) were independent samples, it was not possible to match both datasets for longitudinal analysis.
4.4 Analysis of information

Analysis was made according to livelihood framework by characterizing and comparing and describing changes on four aspects: a) asset endowment b) livelihood strategies c) natural resources based activities d) effects on livelihood security and environmental sustainability. The variables selected for the analysis and their description are summarized in table 3.

According to the variables selected, different statistical tests were performed, using Stata 11 statistical software. For continuous variables, a T-test was used when both sample populations were normally distributed with equal population variances (Mcclave and Sincich, 2009). In other case, Mann Whitney test was applied, which is a non-parametric tests used as an alternative to the t-test when the assumptions of normality and homogeneity of variance are not met (Black, 1999).

For nominal variables, the Chi square and Fisher exact test was applied. According to literature, the latter is more accurate than the chi-square test when expected numbers are small. The null hypothesis for this test is that relative proportions of one variable are independent of the second variable.
<table>
<thead>
<tr>
<th>Asset endowment</th>
<th>Physical Capital</th>
<th>Natural resource based activities</th>
<th>Livelihood Security</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>Total area of farms (ha)</td>
<td>Crop area (ha)</td>
<td>Annual revenue from cocoa (colones)</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>Farms per household (number)</td>
<td>Cocoa area (ha)</td>
<td>Annual revenue from banana production (colones)</td>
</tr>
<tr>
<td>Education of household head (years)</td>
<td></td>
<td>Banana area (ha)</td>
<td>Annual revenue from plantain production (colones)</td>
</tr>
<tr>
<td>Household members (number)</td>
<td></td>
<td>Plantain area (ha)</td>
<td>Total revenue per household</td>
</tr>
<tr>
<td><strong>Social Capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization to which household are members (name)</td>
<td>Has fruit trees (yes/no)</td>
<td>Other crops area (ha)</td>
<td>Total revenue per household members (colones)</td>
</tr>
<tr>
<td>Linking time to Organizations (years)</td>
<td>Has wood trees (yes/no)</td>
<td>Annual yield (kg / ha)</td>
<td></td>
</tr>
<tr>
<td>Training received (type)</td>
<td>Fruit trees per household (ha)</td>
<td>Volume of cocoa production (kg/year)</td>
<td></td>
</tr>
<tr>
<td>Organizations by household (number)</td>
<td>Wood trees per household (ha)</td>
<td>Annual price of Cocoa (colones/kg)</td>
<td></td>
</tr>
<tr>
<td>Training and technical assistance per household (number)</td>
<td>Agroforestry system with fruit trees and wood trees (yes/no)</td>
<td>Cocoa Volume commercialization (kg)</td>
<td></td>
</tr>
<tr>
<td><strong>Natural Capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has fruit trees (yes/no)</td>
<td>Agroforestry only fruit trees (yes/no)</td>
<td>Cocoa plots per household (number)</td>
<td>Adoption of agroforestry systems with timber and fruit trees (yes/no)</td>
</tr>
<tr>
<td>Has wood trees (yes/no)</td>
<td>Agroforestry only wood trees (yes/no)</td>
<td>Banana plots per household (number)</td>
<td>Shade trees species (number)</td>
</tr>
<tr>
<td>Fruit trees per household (ha)</td>
<td>No adoption of shade (yes/no)</td>
<td>Plantain plots per household (number)</td>
<td></td>
</tr>
<tr>
<td>Wood trees per household (ha)</td>
<td>Tress species per Household (number)</td>
<td>Other crops plots per household (number)</td>
<td></td>
</tr>
<tr>
<td><strong>Physical Capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total area of farms (ha)</td>
<td>Tress species for shade (type)</td>
<td>Cocoa share on crops annual revenue by household (%)</td>
<td></td>
</tr>
<tr>
<td>Farms per household (number)</td>
<td>Density per specie of shade (ha)</td>
<td>Cocoa share in total annual revenue by household (%)</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Sustainability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaption of agroforestry systems with timber and fruit trees (yes/no)</td>
<td>Water sources (number)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shade trees species (number)</td>
<td>Forest area (ha)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own elaboration
5 Results and Discussion

The results of this study and its discussion are divided in four parts, based on the structure of the framework for micro policy analysis of rural livelihoods, Ellis (2000). The first part makes a descriptive analysis by comparing asset endowment by household for four asset types for which information was available for 2008 and 2012. The first part ends with an asset endowment comparison for the two years by income-wealth groups identified. The second part analyzes the livelihood strategies identified by explaining the typologies, household revenue portfolios, asset endowment of the households according to the livelihoods typologies, and finally the livelihood strategies according to the three income-wealth groups identified. The third part analyzes the natural resource-based activities. The fourth part finalizes with an analysis of the effects on livelihood security and environmental sustainability of project participants for both years compared.

5.1 Asset endowment

This section presents the results of the comparison of four different capitals for the years 2008 and 2012. In relation to financial capital, information was not available for a comparison for the years mentioned above. The results presented explain the conditions of each capital in Talamancan for each year separately, and finalize with a comparison of the capitals per households for the years mentioned above.

5.1.1 Human capital

The analysis made shows the demographic data for 2008 concerning the population under study of Talamanca, with a total of 101 households for which the baseline questionnaire was applied, representing 365 individuals. The gender distribution of the total population was 53% male and 47% female.

For the 2008 baseline, the average members per household are 3.59 members. The gender of the households’ heads is distributed as 24.75% females and 75.25% males. The average age of the household head is 48.69 years.

Almost 37.62% of the household heads have not received formal education. The median is 5 years of education per household: 4 years for households with female household heads, and 5 years for male household heads. A total of 37.62% of household heads have finished primary education, but no household heads have university or technical education.
In the 2012 survey, a questionnaire was applied across 100 households, consisting a total of 451 individuals. Of the total population, 52.8% were males and 47.2% were females. The average age per household was 48.37 years.

In the comparison of age for household heads between 2008 and 2012, the t-test was applied, since the samples fulfilled the assumptions of normality and homogeneity of variance. Regarding age per household head, no significant statistical differences are found between the years compared.

Table 4 compares key variables of the human capital for the years 2008 and 2012. The comparison was made using information of the household heads interviewed for the two years.

Table 4. Human capital by household

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Household head age (years)</td>
<td>100</td>
<td>48.69</td>
</tr>
<tr>
<td>Education of household (years)</td>
<td>101</td>
<td>3.69</td>
</tr>
<tr>
<td>Household Members (number)</td>
<td>101</td>
<td>3.59</td>
</tr>
<tr>
<td>Gender feminine %</td>
<td>101</td>
<td>24.75</td>
</tr>
<tr>
<td>Gender masculine %</td>
<td>101</td>
<td>75.25</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.
Source: Own elaboration.

Regarding years of education per household, we reject the null hypothesis that years of education are equal. The mean of total years of education increased to 6.30 for 2012. In relation to the number of households, there is a significant difference in the mean of household members for 2008, where there were 3.59 members while in 2012 there were 4.51 members per household. Gender variables for both years show statistically significant differences in both genders for the two samples among years.

The two samples have similar indicators but differ with the variables on education per household head and the number of members of each household. The 2008 sample has more years of total education and household members on average.
5.1.2 Social capital

Project participants maintain relations with different state institutions, social and community development organizations, as well as other international organizations and private companies.

For 2008, there were a total of 13 organizations in which the households were involved. Among the organizations that maintain influence with the households of the agricultural sector in the area, we find APPTA, ACOMUITA, committee aqueduct, radio committee, emergency committee, health committee and the school board.

88% of the households are part of APPTA or ACOMUITA in 2008. With ACOMUITA, the average linking time in years for producers in Talamanca is 9 years, while for APPTA, it was an average 12 years. Most of the producers are partners and participate in at least one meeting a year. The decision to link with the organization is based primarily on the ability to access best cocoa prices and training.

85% of APPTA household members take part in at least one meeting a year, while for the associates of ACOMUITA, 86.67% participate in at least one meeting a year. Regarding capacitation and training, 67% of the producers have received at least one capacitation or training in 2008. Trainings are mostly related with pruning (47.73%), cocoa management (17.05%) pest management (9%).

In the 2012 survey, 22 organizations were registered as the institutions for which cocoa producers of PCC were linked. A total of 54.71% of the producers were associated with APPTA, followed by ACOMUITA with 13.93% and TROBANEX with 9.84%. The average age in years of producers belonging to APPTA is 14, for ACOMUITA is 16 and for TROBANEX an average of 12.66.

Regarding technical assistance and training, 79.41% of the producers took part in the farmer field school, a service provided by PCC staff and partners for participants of the project. The aim of these schools was to introduce and explain topics regarding reproductive biology and vegetative propagation of cocoa. Of the households analyzed, 79% received at least one capacitation and training for this year.
Table 5 compares key variables of the human capitals for the years 2008 and 2012. The comparison was made using information of the household heads interviewed for the two years.

Table 5. Social capital by household

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th></th>
<th>2012</th>
<th></th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations by Household</td>
<td>N=97</td>
<td>Mean</td>
<td>Sd=0.51</td>
<td>N=100</td>
<td>Mean=1.22, Sd=0.90</td>
</tr>
<tr>
<td>Training and Technical Assistance per Household</td>
<td>N=98</td>
<td>Mean</td>
<td>Sd=0.41</td>
<td>N=100</td>
<td>Mean=1.07, Sd=0.74</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Own elaboration

The number of organizations per household shows no significant statistical differences. There is a significant statistical difference for the number of training and technical assistance per household. Therefore, we can reject the $H_0$ that training and technical assistance per household is equal for the two years in comparison, meaning that on average, the number of training and technical assistance per household increased from 0.78 in the baseline survey to 1.07 in 2012.

5.1.3 Physical capital

Physical assets indicate the extent to which households can accumulate goods. In this section, analysis will be given to two characteristics: Total area of the farms and number of farms. Of the total area of farm per household for 2008, 88% of the farmers have on average 3 hectares or less, 35% of them have 1 hectare, 21% have 2 and 10% have 3 hectares as farm area on average. The average farm area per household in 2008 is 2.15 hectares per farmer.

The 2008 sample has a high variation in the size of the farms in hectares, ranging from farms of 0.5 hectares to farms of 40 hectares. From the total sample, 17% have 1 hectare as farm area, 12% have 1.5 hectares, 15% have 2 hectares and 10% have 3 hectares as farm area. Average total area per farm by household for 2012 is 3.19 hectares.
Regarding conservation practices applied by farmers for 2008, 22.77% of the farmers used live barriers and 7.92% used dike or dykes. None of the farmers interviewed used irrigation systems.

Table 6 summarizes and compares the main differences from the data by household gathered for the years 2008 and 2012.

Table 6. Physical capital by household

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th>2012</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area farms (ha)</td>
<td>101</td>
<td>2.15</td>
<td>2.23</td>
</tr>
<tr>
<td>Farms per Household (number)</td>
<td>101</td>
<td>1.20</td>
<td>0.45</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively. Source: Own elaboration.

Area of farm per household shows significant statistical differences. The average area size is 2.15 hectares per household for 2008 and 3.19 hectares in 2012. The number of farms for each household also has a significant statistical difference; it increased from 1.20 farms per household in 2008 to 1.4 farms in 2012.

5.1.4 Natural capital

The use of shadow in cocoa is a traditional activity in household farms and greatly influences the sustainability of the crops production. Regarding this capital, focus will be given to the characteristics of shade for cocoa, number of water sources and forest area. As explained by Ellis (2000), this capital comprises land, water and biological resources used by the households to generate means of survival; such is the case of the different tree species used as shade for cocoa by the members of PCC in Talamanca.

For 2008 project participants Laurel (Cordia alliodora) represents 35.82% of the shade used by the farmers during this period. Laurel is preferred among producers because of its ease of regeneration, its possibility of being combined with other crops, and its use as timber on the farm. Producers dedicated 1.59 hectares to this species. The height on average for this tree is 18.45 meters, and the density (trees/ha) is 40.74. In 2008, 18 species of trees for shade were reported, with 54% of the producers consuming the shade for cocoa.
In 2012, of the cocoa producers that used shade for cocoa, 95% consume from the different species of shade used in the farm. In 2012, 37 species of tree species used for shade were reported. The most common species of shade for cocoa was Laurel, representing 35.4%, Cedro (*Cedrela odorata*) representing 12.77% and Pejibaye (*Bactris gasipaes* K.) representing 12.04%. The average number of tree species per household was 2.78, the area dedicated by household to timber trees was 4.36 hectares (sd 13.30) while for fruit trees was 2.16 hectares (sd 5.52).

On average, the area dedicated to timber trees and fruit trees is 1.54 hectares for each type. The most common agroforestry system used in 2008 was only timber trees with 35% of the cocoa producers using this type, followed by agroforestry systems with timber and fruit trees with 31.68%, and finally fruit trees agroforestry systems representing 26.73%. Only 5.94% of the households interviewed did not use shade.

In 2012, agroforestry systems of fruit and timber trees is the most applied by population under study with 55% of producers, followed by only timber trees agroforestry system with 43%. 1% used agroforestry systems of only fruit trees and 1% did not use shade.

In relation to conservation practices in 2012, the three most common practices of producers are: breeding 10.77%, pruning 10.23% and soil management 10.66%. For households interviewed in their farms there is a variety of arrangements based on agroforestry cocoa cultivation.

Regarding water source per farm for 2008, 81.19% of the households had no water sources in their farms, 6.93% had 1 water source and 5.94% had 2 water sources per farm. For 2012, 70% of the households had no water sources, 23% has at least 1 water source, 4% had 2 water sources, 2% had four water sources, and 1% had 10 water sources.

Regarding the tenancy of forest in the farms, 84 out of 101 household interviewed for 2008 do not have area dedicated to forest. Of the 2012 sample, 84% dedicate between 11.11% and 14.51% of their areas to forests.

Table 7 compares the conditions of natural capital for 2008 with 2012.
Table 7. Natural capital by household

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th></th>
<th></th>
<th>2012</th>
<th></th>
<th></th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Sd</td>
<td>N</td>
<td>Mean</td>
<td>Sd</td>
<td></td>
</tr>
<tr>
<td>aHas fruit trees (yes/no)</td>
<td>101</td>
<td>0.58</td>
<td>0.49</td>
<td>56</td>
<td>1</td>
<td>0</td>
<td>0.7299</td>
</tr>
<tr>
<td>aHas timber trees (yes/no)</td>
<td>101</td>
<td>0.67</td>
<td>0.47</td>
<td>98</td>
<td>1</td>
<td>0</td>
<td>0.0000***</td>
</tr>
<tr>
<td>aFruit trees area per Household (ha)</td>
<td>97</td>
<td>1.54</td>
<td>2.47</td>
<td>100</td>
<td>2.16</td>
<td>5.52</td>
<td>0.3703</td>
</tr>
<tr>
<td>aTimber trees area per Household (ha)</td>
<td>97</td>
<td>1.74</td>
<td>2.52</td>
<td>100</td>
<td>4.36</td>
<td>13.01</td>
<td>0.0005***</td>
</tr>
<tr>
<td>bAgroforestry system with fruit trees &amp; timber trees (yes/no)</td>
<td>101</td>
<td>0.31</td>
<td>0.46</td>
<td>100</td>
<td>0.55</td>
<td>0.5</td>
<td>0.0009***</td>
</tr>
<tr>
<td>bAgroforestry with only fruit trees (yes/no)</td>
<td>101</td>
<td>0.26</td>
<td>0.44</td>
<td>100</td>
<td>0.01</td>
<td>0.1</td>
<td>0.0000***</td>
</tr>
<tr>
<td>bAgroforestry with only timber trees (yes/no)</td>
<td>101</td>
<td>0.35</td>
<td>0.48</td>
<td>100</td>
<td>0.43</td>
<td>0.49</td>
<td>0.2869</td>
</tr>
<tr>
<td>bNo shade (yes/no)</td>
<td>101</td>
<td>0.05</td>
<td>0.23</td>
<td>100</td>
<td>0.01</td>
<td>0.1</td>
<td>0.0567**</td>
</tr>
<tr>
<td>cTress species per Household (number)</td>
<td>97</td>
<td>1.95</td>
<td>0.92</td>
<td>100</td>
<td>2.78</td>
<td>1.02</td>
<td>0.0000***</td>
</tr>
<tr>
<td>cTimber trees species per household (number)</td>
<td>97</td>
<td>1.06</td>
<td>0.88</td>
<td>100</td>
<td>1.68</td>
<td>0.89</td>
<td>0.0000***</td>
</tr>
<tr>
<td>cFruit trees species per household (number)</td>
<td>97</td>
<td>0.86</td>
<td>0.79</td>
<td>100</td>
<td>1.05</td>
<td>1.06</td>
<td>0.3718</td>
</tr>
<tr>
<td>Area of forest per household (ha)</td>
<td>101</td>
<td>1.10</td>
<td>6.17</td>
<td>100</td>
<td>1.06</td>
<td>3.25</td>
<td>0.0000***</td>
</tr>
<tr>
<td>Water source per household (number)</td>
<td>101</td>
<td>0.40</td>
<td>1.01</td>
<td>100</td>
<td>0.49</td>
<td>1.21</td>
<td>0.1422</td>
</tr>
</tbody>
</table>

a Tenure of trees per household, b Agro forestry systems of the households, c Species of trees per Household
* *, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.
Source: Own elaboration.

With respect to the tenancy of only fruit trees, there are no statistical differences between the two years. On the contrary, having only timber trees presents significant statistical differences. Fruit tree areas in hectares by household has no statistical difference for the periods analyzed. Timber tree areas in hectares per household has a statistical difference since it increased from 1.74 in 2008 to 4.36 hectares for 2012. The species of timber used represent a diversification on the livelihood strategies for cocoa producing households in Talamanca.

The second part of the table describes the agroforestry systems adopted by the households for the two years in comparison. PCC promoted among project participants the utilization of diversified agroforestry systems for cocoa production in Talamanca.

Statistically significant differences were found for agroforestry systems with fruit and timber trees. On average, 31% of the households in 2008 had this type of agroforestry system, while for 2012 it was 55%. With regards to the use of agroforestry systems with
only fruit trees, a statistically significant difference is found in 2008: 27% of the households interviewed used this system while in 2012, it was 1% of households interviewed. Project participants that did not use shade show a statistically significant difference for the years: in 2008 it represented 6% of the total households while for 2012, 1%.

In relation to tree species used by households, there is evidence for a statistically significant difference of number of species used for shade in the two years. In 2008, the average species per household was 1.95; while for 2012 it meant 2.78 species on average. The number of timber species per household show significant statistical difference: there was an increase of 1.06 timber species by household for 2008 compared to 1.68 timber species in 2012.

Area of forest per household shows a statistically significant difference; area dedicated to forest in hectares is 1.10 hectares on average for 2008 and 1.06 hectares for 2012. In relation to the number of water sources per household, there are no statistically significant differences: for 2008, there were 0.40 water sources per household while for 2012 there were 0.49.

5.1.5 Household assets endowment by income-wealth groups

As previously explained, the livelihood approach places importance on the assets, with special attention by the assets possessed by the poor. As explained by Ellis (2000), these assets of the poor can be converted into tools that will increase resilience and security of the livelihoods.

The results of household assets by income group are presented in table 8.
Table 8. Household assets by Income Group

<table>
<thead>
<tr>
<th>Asset</th>
<th>Statistic</th>
<th>2008 (n=88)</th>
<th>2012 (n=88)</th>
<th>P</th>
<th>2008 (n=8)</th>
<th>2012 (n=10)</th>
<th>P</th>
<th>2008 (n=5)</th>
<th>2012 (n=2)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>Mean</td>
<td>48.74</td>
<td>47.76</td>
<td>0.7369</td>
<td>51.50</td>
<td>55.70</td>
<td>0.4772</td>
<td>43.40</td>
<td>38.50</td>
<td>0.6959</td>
</tr>
<tr>
<td>Gender of household head (male)</td>
<td>%</td>
<td>0.75</td>
<td>0.77</td>
<td>0.860</td>
<td>0.75</td>
<td>0.60</td>
<td>0.638</td>
<td>0.80</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Education of household head (years)</td>
<td>Mean</td>
<td>3.49</td>
<td>6.17</td>
<td>0.0000***</td>
<td>5.50</td>
<td>7.00</td>
<td>0.9529</td>
<td>4.40</td>
<td>8.50</td>
<td>0.3196</td>
</tr>
<tr>
<td>Household members (number)</td>
<td>Mean</td>
<td>3.77</td>
<td>4.66</td>
<td>0.0039***</td>
<td>2.25</td>
<td>3.70</td>
<td>0.1356</td>
<td>2.60</td>
<td>2.00</td>
<td>0.1797</td>
</tr>
<tr>
<td><strong>Social Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizations to which households are members (number)</td>
<td>Mean</td>
<td>1.18</td>
<td>1.19</td>
<td>0.8651</td>
<td>1.13</td>
<td>1.60</td>
<td>0.3767</td>
<td>1.00</td>
<td>0.50</td>
<td>0.1138</td>
</tr>
<tr>
<td>Trainings received per household (number)</td>
<td>Mean</td>
<td>0.80</td>
<td>1.05</td>
<td>0.0037***</td>
<td>0.75</td>
<td>1.30</td>
<td>0.4893</td>
<td>0.40</td>
<td>1.00</td>
<td>0.1797</td>
</tr>
<tr>
<td><strong>Physical Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of farms per household (ha)</td>
<td>Mean</td>
<td>2.77</td>
<td>5.22</td>
<td>0.0028***</td>
<td>6.97</td>
<td>4.40</td>
<td>0.5018</td>
<td>1.70</td>
<td>2.50</td>
<td>0.8392</td>
</tr>
<tr>
<td>Farms per household (number)</td>
<td>Mean</td>
<td>1.22</td>
<td>1.40</td>
<td>0.0339**</td>
<td>1.25</td>
<td>1.40</td>
<td>0.7337</td>
<td>1.00</td>
<td>1.50</td>
<td>0.1138</td>
</tr>
<tr>
<td><strong>Natural Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agroforestry system of timber &amp; Fruit trees (1=Adoption, 0=No Adoption)</td>
<td>%</td>
<td>35.22</td>
<td>54.5</td>
<td>0.0100**</td>
<td>0</td>
<td>50</td>
<td>0.019**</td>
<td>20</td>
<td>100</td>
<td>0.053**</td>
</tr>
<tr>
<td>Shade trees species (number)</td>
<td>Mean</td>
<td>2.04</td>
<td>2.77</td>
<td>0.0000***</td>
<td>1.5</td>
<td>2.8</td>
<td>0.0055***</td>
<td>1.2</td>
<td>3</td>
<td>**</td>
</tr>
</tbody>
</table>

* *, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Own elaboration
The analysis compares the assets of three different income groups identified; these groups were classified according to Costa Rica’s rural poverty lines determined by the Costa Rican Institute for Statistics and Census (INEC). The first income group is rural, extremely poor households. According to INEC, for 2008 an extreme poor rural household earned 33,289.00 colones or less per month, while for 2012 these households earned 37,287.00 colones or less monthly.

The second income group for the analysis is “rural poor. In 2008, a rural poor household earned 64,625.00 colones or less per month, while for 2012 the monthly income for a rural poor household was 75,580.00 colones or less. The third income group is non-poor households, who earned more than the maximum income generated by poor households for 2008 and 2012 respectively.

Regarding human capital, assets results show no significant statistical differences for age of the household head and gender of household heads across the three types of income-wealth groups; however, results show that the wealthiest income group has, on average, lower age of household heads compared to the extreme poor and poor households.

Similar to findings of Martinez (2007) in the state of Tabasco, Mexico, the poorest income-wealth groups have lower total years of formal education. Results show that total years of education for household heads show significant statistical differences for the extreme poor households. In 2008, the average years of total education were 3.49 while for 2012, a significant 6.17 years. Households with higher number of total years of education are located on the non-poor for 2012.

Number of members per household has significant statistical differences only for the extreme poor households; there was an increase from 3.77 to 4.66 members per household from 2008 to 2012 respectively.

In relation to social assets, results depict no statistically significant differences regarding number of organizations to which the project participants belong. An increase in the number of annual training and technical assistance was found showing a statistically significant difference for extreme poor households, from 0.80 for 2008 increasing to 1.05 for 2012.

Total area of farms and numbers of farms show statistically significant differences. Both show an increase from 2008 to 2012 for extreme poor households participating in the
project. For this income-wealth group, the total area of farms increased from 2.77 to 5.22 hectares on average.

Natural Capital comprehends, as explained by Ellis (2000), biological resources used by people to generate means of survival. One of the objectives of PCC with project participants was to enhance cocoa producers to adopt sustainable practices such as the case of the adoption of different tree species and increase diversity of the trees used as shade for cocoa farming.

Agroforestry systems with timber and fruit trees and number of shade tree species show statistically significant differences for extreme poor and poor households through an increase in the adoption of both practices. For 2008, 31 extreme poor households adopted agroforestry systems of timber and fruit trees, while for 2012 the households adopting the systems totaled 48; almost half of the households participating in the project for 2012. Regarding poor households, none of the project participants adopted such agroforestry systems in 2008, while in 2012 it was 50%.

Number of tree species for the extreme poor households were 2.04 species on average per household, and increasing to 2.77 for 2012. Results indicate that for poor households, the number of shade species also increased from 1.5 to 2.8 per household.

5.2 Livelihood strategies

5.2.1 Livelihood strategy typology

The typologies constructed were based on Tanzania rural case studies of Ellis (2000), in which robust types of farms are identified by the proportional contribution from each activity to the total household income, regrouping data for more homogenous groups with the aim to make comparisons by year. The method applied tries to explain which types of strategies are followed by types of groups constructed.

Piya and Joshi (2011) found that more than two livelihood strategies were recognized for indigenous communities in Nepal. For the matter of the study, the principal activities identified are: crop production (cocoa, banana, plantain), off farm activities (employment on governmental positions, study scholarships, retirement payments) and diversified income (mixture of agricultural activities with off-farm activities). Chimhowu and Hulme (2006), explain that diversification is a crucial element in any discussion of livelihoods.
Households were classified by whether they obtained more than 70% of their total revenue from cocoa production, more than 70% of their total revenue from off farm activities, and a third group which refers to participants without a specific percentage of their revenue either from cocoa production or off farm activities, but from diversified livelihood strategies. The proportions, description and typology per year are summarized in Table 9.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Percentage of households 2008</th>
<th>Percentage of households 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoa 70%</td>
<td>Households that generate more than 70% of its total revenue from cocoa production.</td>
<td>39.6</td>
<td>37</td>
</tr>
<tr>
<td>Off farm 70%</td>
<td>Households that generate more than 70% of its total revenue from off farm activities.</td>
<td>26.73</td>
<td>26</td>
</tr>
<tr>
<td>Diversified</td>
<td>Households that diversified their revenue from agricultural and non-agricultural activities.</td>
<td>22.66</td>
<td>37</td>
</tr>
</tbody>
</table>

Source: Own elaboration.

5.2.2 Household revenue portfolios

It is vital to understand how projects participants make their living. Revenue portfolios were constructed for each type of household livelihood strategy according to the different income activities performed by the households for the years 2008 and 2012.

Similar to the heterogeneity found by Ellis (2000) in the Tanzania case study, Figure 5 reveals the heterogeneity of the household’s livelihoods strategies for 2008 and 2012 according to the activities that generate the majority of their revenue.

Figure 5 describes groups of households who generated more than 70% or more of its annual revenue from cocoa for 2008 received 94% of its total income from cocoa production, 2% from animal activities, 0% from off farm revenue and 4% income from other crops.

For 2012, results show that group of households for which cocoa production represents more than 70% or more for its total revenue, 93% of total revenue comes from cocoa production, no revenue from animal activities or off farm activities, and 7% of its annual total revenue from other crops.
For the second type of livelihood strategy, in 2008, income generated from cocoa production represented 4% of total income, from animal activities 1%, from off farm activities, 93% of total income, and from other crops, 2%.

For households generating 70% or more of its total revenue from off-farm activities in 2012, cocoa production accounted for 6% of total income, animal activities did not represent income, off-farm activities represented 93%, and production of other crops resulted in 1%.

For the group of households who belong to the livelihood strategy of diversified income, for 2008 of its total income, cocoa production meant 29%, income from animal activities was 11%, off farm activities 5%, and other crop production meant 52% of total income. For the same income group in 2012, cocoa production was 22%, animal activities meant 22%, off farm activities was 12%, while production of other crops meant 37% of total income.

Figure 5. Household net revenue portfolio by livelihood strategy for 2008 and 2012

Source: Own elaboration.

For the different groups of livelihood strategies identified and analyzed, results depict that the group generating a majority of its income from cocoa maintains a similar dependency of the crop for the two years compared. The same tendency is found regarding household that belongs to the group that depends mainly on off farm activities for its total revenue.
In relation to the group of households who generate their total revenue from diversified activities, the results of 2008 are different when compared to 2012. Revenue-generating activities are almost evenly distributed in percentages, with a small difference related to off farm activities percentage contribution to total revenue with 5% in 2008 to 12% for 2012.

5.2.3 Household assets endowment by livelihood strategy

This section describes the assets, with a distinction made by livelihood strategies chosen by household participants. The highest average age of household heads is found in households who generate 70% or more of its income from off farm activities; the highest average is found for 2012 with 54 years on average. The lowest average age is found for households that generate 70% or more of their income from cocoa production, with 44.51 years on average for their household heads. Statistically significant differences were found regarding age per household head for livelihoods that diversified their sources of revenue and for livelihoods relying on cocoa as the main source of revenue.

In relation to the gender of household heads, households that generate 70% or more of their revenue from cocoa production, 81% of it are males, while the lowest percentage of male household heads is found for 2008, with 70%, for households that generate 70% or more of their revenue from cocoa production.

Total years of education of household heads is higher for households that generate 70% or more of their income from off farm activities for 2012, with 7.19 years on average; the lowest average is found for groups that diversified their income in 2008 with 3.38 on average. Number of household members is higher for groups that diversified their income, with 4.81 members on average; the lowest quantity of household members is found for households that generate 70% or more of their income from cocoa production, with 3.20 members per household on average.
Table 10. Household assets, by type of livelihood strategy

<table>
<thead>
<tr>
<th>Asset</th>
<th>Statistic</th>
<th>Livelihood Cocoa more than 70% of total revenue</th>
<th>Livelihood off farm more than 70% of total revenue</th>
<th>Livelihood Diversified revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2008 (n=40)</td>
<td>2012 (n=37)</td>
<td>2008 (n=27)</td>
</tr>
<tr>
<td><strong>Human Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>Mean</td>
<td>46.74</td>
<td>44.51</td>
<td>51.41</td>
</tr>
<tr>
<td>Gender of household head (male)</td>
<td>%</td>
<td>0.70</td>
<td>0.81</td>
<td>0.69</td>
</tr>
<tr>
<td>Education of household head (years)</td>
<td>Mean</td>
<td>3.70</td>
<td>5.97</td>
<td>4.07</td>
</tr>
<tr>
<td>Household members (number)</td>
<td>Mean</td>
<td>3.20</td>
<td>4.08</td>
<td>0.0387</td>
</tr>
<tr>
<td><strong>Social Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizations to which the households are member (number)</td>
<td>Mean</td>
<td>1.18</td>
<td>1.08</td>
<td>0.6451</td>
</tr>
<tr>
<td>Trainings received per household (number)</td>
<td>Mean</td>
<td>0.87</td>
<td>1.11</td>
<td>0.642</td>
</tr>
<tr>
<td><strong>Physical Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of farms per household (ha)</td>
<td>Mean</td>
<td>2.33</td>
<td>4.95</td>
<td>0.0006***</td>
</tr>
<tr>
<td>Farms per household (number)</td>
<td>Mean</td>
<td>1.15</td>
<td>1.46</td>
<td>0.0215***</td>
</tr>
<tr>
<td><strong>Natural Capital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area forest per household (ha)</td>
<td>Mean</td>
<td>1.80</td>
<td>1.08</td>
<td>0.0000***</td>
</tr>
<tr>
<td>Agroforestry systems of timber and fruit trees per household (yes/no)</td>
<td>%</td>
<td>0.35</td>
<td>0.65</td>
<td>0.009***</td>
</tr>
<tr>
<td>Agroforestry systems of only timber per household (yes/no)</td>
<td>%</td>
<td>0.35</td>
<td>0.00</td>
<td>0.220</td>
</tr>
<tr>
<td>Agroforestry systems of only fruit trees per household (yes/no)</td>
<td>%</td>
<td>0.23</td>
<td>0.35</td>
<td>0.0000***</td>
</tr>
<tr>
<td>Shade trees species (number)</td>
<td>Mean</td>
<td>2</td>
<td>2.70</td>
<td>0.0017***</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Own elaboration
Two variables are analyzed for social assets. The first is the number of organizations to which the households belong, which shows no statistically significant difference. The average oscillates between 1.08 and 1.41 organizations per household. The second is the number of training received by each household, which is lower for households that generate 70% or more of their income from off farm activities for 2008 with 0.56 trainings received annually, while for the groups who diversified their income in 2012, the number of training is the highest with 1.19 times, annually.

For physical capital, the total area of farms in hectares per household is higher for the households who diversified their income as livelihood strategy for 2012 with 6.01 hectares on average. Statistically significant differences are found for households that generate 70% or more of their income from cocoa production: in 2008 the average area was the lowest with 2.33 hectares. The number of farms per household for each group does not have big differences; the average number oscillates from 1.15 to 1.46 farms by each household. The number of farms shows statistically significant differences as it increased for households generating the majority of its income (>70%) from cocoa farming.

Natural capital is analyzed in four variables; total area of forest per household is higher for households that generate 70% or more of their total revenue from cocoa production and shows statistically significant differences as it decreased from 1.80 hectares in 2008 to 1.08 hectares on average for 2012. The least area of forest is found for the second type of livelihood strategy in 2012 with 0.58 hectares. For all livelihood strategies, statistically significant differences were found regarding area dedicated to forest.

An agroforestry system of timber and fruit trees per household show the highest rates of adoption for households that generate 70% or more of their revenue from cocoa production and off farm activities with 65% of adoption. Statistically significant differences are found for the first two livelihood strategies, as the average adoption rates in both cases increased.

Agroforestry systems of only timber trees were adopted by 38% of the households who generate their income from diversified activities for 2008. Statistically significant differences were found, showing the highest percent of adoption for livelihood strategies in comparison. Agroforestry systems of only fruit trees per household were highly adopted by households that generate 70% or more of their income from off farm activities with 67% of adoption.
There is, on average, a higher adoption of different tree species for households that generate 70% or more of their income from off farm activities for 2012 with 2.88 species per household, while the same livelihood strategy for 2008 shows the lowest number of tree species per household with 1.64, depicting statistically significant differences. Statistically significant differences were also found for the other two livelihood strategies. Similarly to findings of Laird et al. (2007) in Mount Cameroon, for the Talamanca region, the majority of tree species are native.

5.2.4 Livelihood strategies classification by income groups

Table 11 shows that there are statistically significant relationships between the livelihood strategies and the three different income groups described for 2008.

<table>
<thead>
<tr>
<th>Livelihood Strategy</th>
<th>Income Group</th>
<th>Cocoa 70%</th>
<th>Off-farm 70%</th>
<th>Diversified Income</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Poor</td>
<td></td>
<td>40</td>
<td>16</td>
<td>32</td>
<td>88</td>
</tr>
<tr>
<td>Poor</td>
<td></td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Non Poor</td>
<td></td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>27</td>
<td>34</td>
<td>101</td>
</tr>
</tbody>
</table>

Fisher’s exact = 0.0000
Source: Own elaboration

Extreme poor household’s participants are in their majority associated to cocoa production as main revenue activity, representing 45.45% of this income group, living as second income source diversified activities with 18.18% and on third place off farm activities totaling 36.36% of the extreme poorest participants. Off farm revenue generating activities contain 75% of poor participants; the remaining 25% of household participants diversified their livelihoods to generate revenue.

Table 12 shows statistically significant relationships between the three livelihood strategies and three different income groups for 2012. Table 12 reflects an almost equal balance of livelihood strategies adopted by extreme poor for 2012, where 41% of the extreme poor
participants are in their majority associated to cocoa production as the main livelihood strategy, leaving in second place adoption of diversified livelihood strategies with 39%, and third, off-farm activities with 20%. With regard to poor households participating, 60% of them rely on off-farm activities generating more than 70% of its annual revenue; another 30% diversified their livelihood strategies, leaving cocoa production with only 10% of poor participants. All non-poor participants depend on off-farm activities to generate income.

Figure 6 describes in a radar chart the tendencies of livelihood strategies selected by income groups for 2008 and 2012. No major changes were found with regards to the livelihood strategies chosen by each income-wealth group from 2008 to 2012. Income groups for both years analyzed did not change their livelihoods selection from one period to the other.

Figure 6. Distribution of livelihood strategies, by income group for 2008 and 2012

Non-poor household’s participants have a tendency to perform off farm activities as main source of income, while extreme poor show a tendency to focus on cocoa production as
main source of revenue. Poor participants emphasize its income strategies in their majority on off farm activities.

5.3 Natural resources based activities

This section places attention to project participants characteristics derived from natural resource based activities. Analysis is divided in two sections: the first section comprehends a comparison of the natural resource based activities by plot between 2008 and 2012, and a second part will proceed with an analysis of natural resource based activities by households.

The focus of this section is given to agricultural and other natural based activities that played a major role on the revenue generated by the households. The framework for micro policy analysis of rural livelihoods explains that an important outcome of the framework is the income level and income stability for the households, since both play a determinant role on poor households decision making in relation to the livelihood strategies chosen.

We begin by standardizing the exchange rate from Costa Rica colon to the United States of America dollar.

Table 13. Exchange Rate Colon to US dollars for 2008 and 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Currency</th>
<th>Exchange Rate $</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Colon</td>
<td>0.001885725</td>
</tr>
<tr>
<td>2012</td>
<td>Colon</td>
<td>0.00196711</td>
</tr>
</tbody>
</table>

Table 14 describes and characterizes the natural resource based activities per plot for the two-year analysis between 2008 and 2012, comparing production, yields and commercialization by plot. Natural resource based activities comprehend collection or gathering from the forest, food cultivation, livestock keeping.

Results show that average area per plot has statistically significant differences. In 2008, average area per plot per producer was 1.58 hectares while for 2012 it was 1.45 hectares. With regards to the total revenue in colones from land use, there is also a statistical significant difference. In 2008, average revenue was 71,711.88 colones compared to 50,402.42 colones in 2012. It is important to note that for 2012, the distribution of the data is larger compared to 2008. With regards to area of cocoa in hectares there are no statistically significant differences for these variables so we fail to reject H0.
In relation to revenue from crops, both annual revenue from cocoa per plot and annual revenue from plantain per plot showed no statistically significant differences. This finding is contrary to the case of revenue from banana per plot where there is a significant statistical difference (2008 represented 63,368.53 colones while for 2012 64,601.49).

With respect to cocoa production characteristics per plot, there are statistically significant differences for yield by kilograms per hectares by year. In 2008 yield on average was 209 kilograms per hectare while for 2012, yield was 139.79 kilograms per hectare.

Volume of production in kilograms also has a statistical significant difference. In 2008, the average volume of production was 265.30 kilograms, while for 2012 the average volume of production was 195.26 kilograms.

Price of cocoa per kilogram shows a significant statistical difference as well. In 2008, the average price per kilogram was 346 colones compared to the average price in 2012 of 370.96 colones. The volume of commercialization in kilograms presents a significant statistical difference; in 2008 an average 268.53 kilograms per plot were commercialized while for 2012 the volume of commercialized cocoa was less given an average 196.28 kilograms.

Table 14. Characteristics of natural resource based activities of farmers per plot for 2008 and 2012

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th>2012</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>N 194</td>
<td>Mean 1.587577</td>
<td>Sd 1.98</td>
</tr>
<tr>
<td>Net Revenue in colones</td>
<td>N 194</td>
<td>Mean 71711.88</td>
<td>Sd 102733.7</td>
</tr>
<tr>
<td>Area Cocoa (ha)</td>
<td>N 116</td>
<td>Mean 1.47</td>
<td>Sd 0.98</td>
</tr>
<tr>
<td>Annual revenue Cocoa</td>
<td>N 116</td>
<td>Mean 82278.41</td>
<td>Sd 114195.2</td>
</tr>
<tr>
<td>Annual revenue Banana</td>
<td>N 68</td>
<td>Mean 63368.53</td>
<td>Sd 84193.29</td>
</tr>
<tr>
<td>Annual revenue Plantain</td>
<td>N 3</td>
<td>Mean 19583.33</td>
<td>Sd 16340.77</td>
</tr>
<tr>
<td>Annual revenue others crops</td>
<td>N 7</td>
<td>Mean 0</td>
<td>Sd 0</td>
</tr>
<tr>
<td>Annual Yield (kg/ha)</td>
<td>N 116</td>
<td>Mean 209.54</td>
<td>Sd 172.41</td>
</tr>
<tr>
<td>Volume of cocoa production (kg/year)</td>
<td>N 116</td>
<td>Mean 265.3</td>
<td>Sd 254.58</td>
</tr>
<tr>
<td>Price of Cocoa (colones/kg)</td>
<td>N 110</td>
<td>Mean 346.3</td>
<td>Sd 307.44</td>
</tr>
<tr>
<td>Volume of commercialization of cocoa (kg)</td>
<td>N 112</td>
<td>Mean 268.35</td>
<td>Sd 255.34</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level respectively.

Source: Own elaboration

Table 15 describes and characterizes the use of natural resource based activities by households, comparing the situations found for 2008 with 2012. In relation to the
characteristics of the farm by household, the total income in colones per household shows
differences but these differences are not significant.

Table 15. Characteristics of natural resource based activities of farmers by household for 2008 and 2012

<table>
<thead>
<tr>
<th>Variable</th>
<th>2008</th>
<th></th>
<th>2012</th>
<th></th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Sd</td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Total revenue per household (colones)</td>
<td>101</td>
<td>529,057.10</td>
<td>833,808.10</td>
<td>100</td>
<td>599,422.10</td>
</tr>
<tr>
<td>Cacao plots per household (number)</td>
<td>101</td>
<td>1.15</td>
<td>0.41</td>
<td>100</td>
<td>1.04</td>
</tr>
<tr>
<td>Banana plots per household (number)</td>
<td>101</td>
<td>0.67</td>
<td>0.68</td>
<td>100</td>
<td>0.87</td>
</tr>
<tr>
<td>Plantain plots per household (number)</td>
<td>101</td>
<td>0.03</td>
<td>0.17</td>
<td>100</td>
<td>0.20</td>
</tr>
<tr>
<td>Area Cocoa by household (ha)</td>
<td>101</td>
<td>1.69</td>
<td>1.28</td>
<td>100</td>
<td>1.72</td>
</tr>
<tr>
<td>Area of Banana in per household (ha)</td>
<td>101</td>
<td>1.23</td>
<td>2.81</td>
<td>100</td>
<td>1.24</td>
</tr>
<tr>
<td>Area of Plantain per household (ha)</td>
<td>101</td>
<td>0.08</td>
<td>0.57</td>
<td>100</td>
<td>0.225</td>
</tr>
<tr>
<td>Cocoa annual revenue by household (colones)</td>
<td>101</td>
<td>94,497.97</td>
<td>120,195.30</td>
<td>100</td>
<td>83,274.25</td>
</tr>
<tr>
<td>Banana annual revenue by household (colones)</td>
<td>101</td>
<td>42,663.96</td>
<td>77,371.02</td>
<td>100</td>
<td>56,203.30</td>
</tr>
<tr>
<td>Plantain annual revenue by household (colones)</td>
<td>101</td>
<td>581.68</td>
<td>4,062.50</td>
<td>100</td>
<td>26,095.00</td>
</tr>
<tr>
<td>Volume of production (kg/year)</td>
<td>101</td>
<td>304.70</td>
<td>280.28</td>
<td>100</td>
<td>203.07</td>
</tr>
<tr>
<td>Volume of commercialization of cocoa (kg)</td>
<td>101</td>
<td>297.57</td>
<td>282.38</td>
<td>100</td>
<td>204.13</td>
</tr>
<tr>
<td>% of cocoa on crops annual revenue</td>
<td>99</td>
<td>0.72</td>
<td>0.35</td>
<td>91</td>
<td>0.76</td>
</tr>
<tr>
<td>% of cocoa in on and off farm annual revenue</td>
<td>100</td>
<td>0.49</td>
<td>0.41</td>
<td>97</td>
<td>0.45</td>
</tr>
</tbody>
</table>

* *, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Own elaboration

Cocoa number of plots per household has significant statistical differences. The number of plots found for 2008 was 1.14 plots, while for 2012 it was 1.04 plots. With respect to the number of banana plots per household there is also a significant statistical difference: for 2008 the number of plots of banana per household was 0.67 on average while for 2012, it increased to 0.87 plots.

In relation number of plots per household for plantain and other crops, significant statistical differences were also found. For the first case there was an increase from 0.029 plots per household for 2008 to 0.2 plots for 2012. For the second case, results show there
were 0.69 plots per households of other crops on 2008 and for 2012 there were 1.42 plots per household.

There are no significant statistical differences to the area of cocoa by households, while for the area of banana per household and the area of plantain per household significant statistical differences were found; area of bananas in 2008 was 1.22 hectares while for 2012 it was 1.24 hectares; plantain also increased in the area dedicated by household from 0.079 hectares to 0.225 hectares.

Cocoa and banana annual revenue by household show no significant statistical differences for the years in comparison. While for plantain there are significant statistical differences, it meant 581 colones on average for 2008 to 26,095.00 colones on average for 2012.

Volume of production in kilograms shows significant statistical differences for the two years. In 2008, the average production was 304.703 kilograms, while in 2012 it decreased to 203.07 kilograms. Volume of commercialization of cocoa in kilograms also has statistically significant differences: in 2008, on average 297.5743 kilograms of cocoa were commercialized while in 2012, less volume was commercialized, 204.13 kilograms on average. As explained below in section 5.2.5, climatic conditions, misapplication of fertilizer and a disease had bad consequences on cocoa production for 2012. Percent of cocoa on crops annual income and percent of cocoa on and off farm annual income do not show significant statistical differences.

5.4 Effects on livelihoods security and environmental sustainability

5.4.1 Revenues according to income groups

Results of revenues generating activities according to income group for which project participants belong to are shown in Table 16. As Ellis (2000) explains on figure 1, livelihood security comprehends a combination of attributes related to income level, income stability as well as reduction in the overall risk profile of the income portfolio, this leads to people becoming less or more vulnerable to shocks.
Table 16. Revenue activities by income group

<table>
<thead>
<tr>
<th>Asset</th>
<th>Statistic</th>
<th>Extreme Poor</th>
<th>Poor</th>
<th>Non Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual total revenue per household (colones)</td>
<td>Mean</td>
<td>299,860.70</td>
<td>380,157.00</td>
<td>0.4831</td>
</tr>
<tr>
<td>Annual cocoa revenue per household (colones)</td>
<td>Mean</td>
<td>98,330.34</td>
<td>77,751.99</td>
<td>0.7026</td>
</tr>
<tr>
<td>Annual off farm revenue per household (colones)</td>
<td>Mean</td>
<td>146,750.00</td>
<td>185,545.50</td>
<td>0.3751</td>
</tr>
<tr>
<td>Annual animal revenue per household (colones)</td>
<td>Mean</td>
<td>14,744.69</td>
<td>38,791.48</td>
<td>0.0123**</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Own elaboration
With regards to Table 16, a Mann-Whitney statistical test was performed. Results show insignificant statistical differences were found between each income group, except for the case of animal revenue in colones where extreme poor household show significant statistical differences, for 2008 annual revenue from animal activities on average represented 14,744.69 colones increasing to 38,791.48 colones per household for 2012, still for extreme poor household this is the revenue generating activity which contributes less to the total revenue of the household.

There is big gap between total revenue per household in colones for extreme poor and poor households participating in the project. Extreme poor households represent almost 90% of the participants of the project for both years compared.

As it will be further explained, cocoa revenue is the main income source for extreme poor households participants, yet results show a decrease of cocoa revenue from 2008 to 2012. According to PCC members staff, for 2012 yields of cocoa decreased as a consequence of lack of rain. Coupled with this situation, the participants did not use the required amounts of fertilizer. In the middle of 2012, a large majority of the cocoa plantations were affected by a plague known as Monilia (*Monilio-phthora roreri*). This disease attacks only the fruits of cocoa; fruits would sporadically appear healthy but are internally damaged, which are recognized as being heavier. High temperatures are more favorable for the spread of Monilia.

For poor households, revenue from cocoa and off farm activities had an increase which is not statistically significant. Off farm revenue is the activity which contributes more to the total revenue for poor participants. Non-poor participants, who represent a small number of the total sample, also rely heavily on off-farm revenue activities.

### 5.4.2 Revenues according to livelihood strategy

As Ellis (2000) explains, livelihood strategies are composed of activities that generate the means of household survival. Table 17 presents the main results according to revenue generated by the different livelihoods strategies identified by PCC participants for 2008 and 2012.
### Table 17. Revenue activities by livelihood strategy

<table>
<thead>
<tr>
<th>Asset</th>
<th>Statistic</th>
<th>2008 (n=40)</th>
<th>2012 (n=37)</th>
<th>P</th>
<th>2008 (n=27)</th>
<th>2012 (n=26)</th>
<th>P</th>
<th>2008 (n=34)</th>
<th>2012 (n=37)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual total revenue per household (colones)</td>
<td>Mean</td>
<td>166,072.50</td>
<td>137,753.90</td>
<td>0.0125**</td>
<td>1,425,319.00</td>
<td>1,305,732.00</td>
<td>0.4337</td>
<td>244,360.30</td>
<td>564,764.30</td>
<td>0.2426</td>
</tr>
<tr>
<td>Annual Cocoa revenue per household (colones)</td>
<td>Mean</td>
<td>157,897.50</td>
<td>124,156.10</td>
<td>0.0727*</td>
<td>39,662.78</td>
<td>55,457.31</td>
<td>0.2505</td>
<td>63,455.88</td>
<td>61,939.46</td>
<td>0.8178</td>
</tr>
<tr>
<td>Annual off farm revenue per household (colones)</td>
<td>Mean</td>
<td>0.00</td>
<td>0.00</td>
<td>N.A</td>
<td>1,357,556.00</td>
<td>1,243,077.00</td>
<td>0.8653</td>
<td>42,352.94</td>
<td>157,189.20</td>
<td>0.0856*</td>
</tr>
<tr>
<td>Annual farming animal revenue per household (colones)</td>
<td>Mean</td>
<td>4,562.96</td>
<td>54.05</td>
<td>0.0052***</td>
<td>5,166.32</td>
<td>800.00</td>
<td>0.0073***</td>
<td>40,243.33</td>
<td>107,874.30</td>
<td>0.6575</td>
</tr>
</tbody>
</table>

*, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.

Source: Owm elaboration.
Results depict a big gap between annual total revenue per household from groups receiving 70% or more of its revenue from off-farm activities versus groups receiving 70% or more from cocoa production.

Annual total revenue per household in colones show significant statistical differences for participants receiving 70% or more from cocoa production, with a decrease from 166,072.50 to 137,753.90 colones between 2008 and 2012 respectively. Similarly, the same participants’ annual revenue from cocoa also feature significant statistical differences with a decrease of 157,897.50 to 124,156.10 colones from 2008 to 2012. As explained in section 5.2.5, due to unfavorable climatic conditions and faulty agricultural practices, cocoa production in 2012 was negatively affected.

Significant statistical differences were found for annual off farm revenue for participants whom revenue comes mainly from diversified livelihood activities. In 2008, off farm revenue meant 42,352.99 colones on average increasing in 2012 to 157,189.20 colones on average. Off farm revenue generating activities had no contribution to total revenue of participants who earn 70% or more of their revenue from cocoa production.

Annual revenue through activities generated by farming of animals show a statistically significant decrease for livelihoods that generated 70% or more of its revenue from cocoa production or off farm activities for 2008 and 2012.

5.4.3 Environmental Sustainability practices

Ellis (2000) refers to environmental sustainability as a process of resilience and stability of resources such as soil, water, forest and biodiversity. A given environment can improve, degrade or continue to be stable. Sustainability of forests for human consumption can be achieved through continuous management by the people.

Table 18 and 19 examine the adoption of sustainable practices for cocoa production according to the income groups to whom household participants belong, or to the livelihood strategies chosen by participants.
Table 18. Comparison agroforestry systems composition by income groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Extreme Poor</th>
<th>Poor</th>
<th>Non-Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008 (n=88)</td>
<td>2012 (n=88)</td>
<td>2008 (n=8)</td>
<td>2012 (n=10)</td>
</tr>
<tr>
<td>Agroforestry system of timber &amp; Fruit trees (1=Adoption, 0=No Adoption)</td>
<td>Frequency</td>
<td>31</td>
<td>48</td>
<td>0.01***</td>
</tr>
<tr>
<td>Shade trees species (number)</td>
<td>Mean</td>
<td>2.04</td>
<td>2.77</td>
<td>0.0000***</td>
</tr>
</tbody>
</table>

* *, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.
Source: Own elaboration

Table 19. Comparison agroforestry systems composition by livelihood strategy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Cocoa 70%</th>
<th>Off-farm 70%</th>
<th>Diversified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008 (n=40)</td>
<td>2012 (n=37)</td>
<td>2008 (n=27)</td>
<td>2012 (n=34)</td>
</tr>
<tr>
<td>Agroforestry system of timber &amp; Fruit trees (1=Adoption, 0=No Adoption)</td>
<td>%</td>
<td>35</td>
<td>64.86</td>
<td>0.009***</td>
</tr>
<tr>
<td>Shade trees species (number)</td>
<td>Mean</td>
<td>2</td>
<td>2.70</td>
<td>0.0017***</td>
</tr>
</tbody>
</table>

* *, ** and *** show that the variable in the row is statistically different between the two years at 10%, 5% and 1% significance level, respectively.
Source: Own elaboration
As Ellis (2000) points out livelihood diversification can be thought of as a positive contribution to sustainable rural livelihoods. Before PCC was implemented, agroforestry systems were already being used for cocoa production in Talamanca; however, PCC enhanced participants to adopt a diversified agroforestry system with timber and fruit trees.

Results in Table 18 demonstrate that there are significant statistical differences for all income groups from 2008 to 2012 with regard to the adoption of agroforestry systems of timber and fruit trees. For extreme poor households, adoption of this agro forestry system increased in participation from 35% for 2008 to 54% in 2012. Poor households participating in the project for 2008 did not have this agroforestry adoption for 2012 meant 100% of poor household participants of PCC.

In relation to adoption of shade tree species, an increase across all income groups was found with significant statistical differences. Extreme poor households increased number of shade tree species from 2.04 on average in 2008 to 2.77 species on average in 2012. Poor households also increased their number of shade tree species on average from 1.5 to 2.8 species on average from 2008 to 2012, respectively.

Table 19 shows results regarding agroforestry systems composition by livelihood strategy. Adoption of agroforestry system of timber and fruit trees increased for the three types of livelihood strategies identified, showing significant differences only for project participants who depend on cocoa as the main source of revenue or participants who generated more than 70% of its income from off-farm activities.

As Laird et al. (2007) found, the use of timber and fruit trees as shade for cocoa is the dominant agroforestry system in Mount Cameroon. Results depict that household participants, who generated more than 70% of its revenue from cocoa, increased the adoption of agroforestry system of timber and fruit trees from 35% in 2008 to 64.86% in 2012. Adoption of agroforestry system of timber and fruit trees for participants who generated more than 70% of its income from off-farm activities increased by half from 2008 to 2012.

The number of shade tree species increased for the three livelihood strategies which household participants mainly perform, showing significant statistical differences for the strategy identified. For participants who depend on cocoa as main source of revenue, the
number of species increased from 2 to 2.70 shade tree species on average from 2008 to 2012. While for participants who generated more the 70% of its income from off-farm activities increased from 1.64 to 2.78 number shade tree species on average from 2008 to 2012. Household participants who diversified their livelihoods strategies increased on average the number of shade tree species from 2.15 in 2008 to 2.78 for 2012.

6 Conclusions

In this study, analysis has been performed on changes in asset endowment and livelihood strategies for project participants between 2008 and 2012 in Talamanca, Costa Rica.

Similar to the findings of Jansen et al. (2006) about rural hillsides in Honduras where the vast majority of households (>90%) are poor, the majority of household participants in Talamanca for PCC (>90%) are also either extreme poor or poor.

a. Asset Endowment

Based on results we can conclude that cocoa households located in Talamanca, Costa Rica have a varied endowment of livelihood assets of which they make use of in different proportions. Of the group of assets, natural capital (land, crops, animals and forest products on the farm) stands out as a highly contributing asset for revenue to the household.

Human capital in cocoa households is characterized by a low level of education, especially among extreme poor household heads. Despite limitations in the area such as the household economic conditions, the lack of schools or difficult to access schools, household heads encouraged their children to attend school looking to have better choices in the future. For this reason, it is common that the children are the ones often seeking to develop themselves in other productive, but non-farm activities for their sustenance and contribution to household revenue.

Regarding social capital, results show a continuous membership of households to APPTA and ACOMUITA, platforms that help cocoa producers commercialize cocoa and receive technical assistance. Results presented depict insignificant statistical differences regarding numbers of organization per household from 2008 to 2012. Meanwhile, the average number of assistance and technical assistance shows significant statistical differences as it increased from 2008 to 2012.
Physical assets show that the number and area of farms per household increased from 2008 to 2012. Extreme poor households were the income group for which area increased the most from 2.77 to 4.53 hectares on average.

b. Livelihood strategies and income groups

Three livelihood strategies were identified: households that generate more than 70% of its total annual revenue from cocoa, households that generate more than 70% of its total annual revenue from off-farm activities, and households that generate their annual revenue from diversified strategies without a fixed percent of any specific activity contributing to its revenue.

Guided by INEC rural poverty lines for Costa Rica, three income groups were formed: extreme poor, poor and non-poor. Households that follow a livelihood strategy based on cocoa are mainly extreme poor participants.

Extreme poor households for both years compared rely mainly on the livelihood strategy that generates the majority of their revenue from cocoa production. Poor and non-poor households rely on off-farm activities as the major contribution to household revenue. Statistically significant relationships were found between the three livelihood strategies and the three different income groups.

c. Cocoa percentage weight in total household revenue

The study demonstrates that cocoa production is an important element for the livelihood strategies of project participants, as it represents an important contribution to household revenue.

Annual cocoa production for participants decreased from an average 304.70 kg in 2008 to 203.07 kg in 2012. Percentage weight of cocoa on agricultural annual revenue increased from 72% in 2008 to 76% in 2012; however this increase is not statistically significant. Percentage contribution for annual revenue decreased from 49% in 2008 to 45% in 2012. Even though domestic and international prices for cocoa increased from 2008 to 2012, cocoa farming itself does not generate enough revenue for household participants to overcome their poverty status; participants relying on cocoa as main livelihood strategy
should diversify their revenue activities, seeking for an increase on households’ total revenue.

d. **Sustainable practices: adoption of shade for cocoa plantation**

Results show higher adoption of agroforestry systems of fruit and timber trees for cocoa production systems by extreme poor and poor household participants. These income-wealth groups are the ones mostly associated to livelihood strategies that rely on cocoa as a major source of revenue for the household.

e. **Did livelihood for project participants improve?**

Livelihoods for project participants increased in the number of different revenue generating activities from 2008 to 2012, especially from forest products. While total revenue and cocoa revenue decreased from baseline conditions to 2012, off-farm activities increased their share in total revenue, with a higher impact on poor and non-poor participants, which constitute a minority of the total project households for both years in comparison; however these differences are not statistically significant.

Cocoa production was affected by unfavorable climatic conditions for production, faulty agricultural practices and the attack of a disease which affected a vast majority of cocoa plantations in 2012. Despite unfavorable cocoa production conditions, the majority of households continue to maintain their crops on the farm.

Maintaining just an economic approach is not sufficient to explain why project participants continue cocoa production despite unfavorable conditions. Cocoa culture in the area and its inherited practices partly explain their attachment to the cultivation of cocoa.

Finally future interventions in Talamanca cocoa producing households shall take deeper considerations on human capital growth. As limitations on production are perceived, further extension and technical assistance on crop management techniques could enable greater productivity. In addition, future studies could address priority issues such as the quality of cocoa produced in the area and establish proposals for improvements. In relation to further evaluations of MAP, use of a control and treatment groups will allow the completion of a longitudinal analysis aiming to understand if effects on project participants are due to the intervention.
7 References


Ellis, F. (2000). Rural Livelihoods and diversity in developing countries. Oxford University Press. US.


