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The Expansion of Coffee Robusta (*C. canephora)* in Nicaragua

Hedvig Hoel Bjørge
Agroecology

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ABSTRACT

An increasing number of small-scale rural farmers in developing countries are involved in the so-called global trade market, producing crops such as coffee, tea, cacao, and banana to the Western Hemisphere. In Nicaragua, the production of coffee is of social, economic, and ecological importance to rural farmers. In 2005, Nestlé and Mercon, a Nicaraguan coffee export company introduced coffee Robusta (*Coffea canephora*) to Nueva Guinea, a municipality in the Caribbean region of Nicaragua. In 2016, over 200 rural farmers had invested in the production of Robusta, and the coffee is sold as instant coffee on the national market. The objective of this study is to analyze the socioecological impacts of the production of Robusta on the farm activities of rural farmers in Nueva Guinea. Based on the sustainable livelihood approach (SLA) I describe historical events that have shaped rural livelihoods in the Caribbean region. I interviewed 36 farmers in Nueva Guinea to gain insight into how they manage Robusta and how the production affects their farm activities. The interviewed farmers in Nueva Guinea went from being subsistence farmers to produce the commercial crop Robusta. The production of Robusta contributes to a positive development for the farmers because it enables them to invest in a high-value crop and to increase their income. Small farms however, reduce their food security because they have planted Robusta on land previously used to grow food crops. All the interviewed farmers apply large quantities of chemicals on the Robusta plants, and this negatively affects their health and the environment. Some farmers use integrated pest management (IPM) and alternative fertilizers on the Robusta plants, and consequently they reduce the chemical applications. To improve the social and environmental sustainability of the Robusta production in Nueva Guinea, it is necessary to find alternative trade networks that can give a higher value to Robusta, than to sell it as instant coffee on the national market. Farmer cooperatives could facilitate market integration, access to credits and certifications for rural farmers in Nueva Guinea, and this way they could sell Robusta at a higher price than what they do on the conventional market.

SAMMENDRAG

Et økende antall småprodusenter i utviklingsland er involverte i det globale handelsmarkedet hvor de produserer kaffe, te, kakao og bananer til vestlige land. I Nicaragua er kaffeproduksjon av sosial, økonomisk og økologisk viktighet for bønder som bor i rurale områder. I 2005 introduserte Nestlé og Mercon, en Nicaraguansk kaffeeksportør, kaffe Robusta (*Coffea canephora*) til Nueva Guinea, en by i den karibiske regionen i Nicaragua. Frem til 2016 hadde over 200 bønder investert i produksjonen av Robusta, og kaffen de produserer selges som pulverkaffe på det nasjonale markedet.

Målet med dette studiet er å analysere den sosiale og miljømessige bærekraftigheten av produksjonen av Robusta i Nueva Guinea. Basert på rammeverket: "Sustainable Livelihood Approach" (SLA) beskriver jeg historiske hendelser som har formet den karibiske regionen i Nicaragua, og dette er utgangspunktet for å forstå hvordan produksjonen av Robusta påvirker bøndene i Nueva Guinea. Jeg intervjuet 36 bønder i Nueva Guinea for å få en innsikt i hvordan de produserer Robusta og hvordan produksjonen påvirker gårdsaktivitetene deres. Bøndene jeg intervjuet gikk fra å være subsistensbønder til å produsere den kommersielle planten Robusta. Produksjonen av Robusta bidrar til en positiv utvikling for bøndene fordi den gir en høy avkastning. Matsikkerheten til småprodusenter reduseres derimot kraftig fordi de planter Robusta på landområder hvor de tidligere dyrket matplanter til eget konsum. De fleste bøndene bruker store mengder kjemikalier på Robusta-plantene og dette påvirker deres helse og miljøet svært negativt. Noen bønder bruker derimot integrert plantevern (IPM) og organisk gjødsel på Robusta-plantene, og dermed reduserer de bruken av skadelige kjemiske midler. For å forbedre den sosiale og miljømessige bærekraftigheten ved produksjonen av Robusta i Nueva Guinea er det nødvendig å finne alternative handelsnettverk som kan gi en høyere verdi for Robusta, i motsetning til å bli solgt som pulverkaffe på det nasjonale markedet. Lokale kaffekooperativer kan tilrettelegge for markedsintegrasjon, tilgang til kreditt og sertifiseringer for kaffeprodusentene i Nueva Guinea, og på denne måten kan de selge Robusta til en høyere pris enn på det konvensjonelle handelsmarkedet.

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INTRODUCTION

Small-scale farmers and free trade

An increasing number of small-scale farmers in developing countries are involved in the so-called global free trade market, producing commercial crops such as tea, coffee, cacao, and banana to the western hemisphere. They produce up to 70% of the world's food supply and are therefore key actors in the global food market (McMichael 2015; Samberg et al. 2016). Small-scale farmers generally combine food crop production for their personal consumption and for market sale. They are sometimes contracted by multinational companies, such as Nestlé and Kraft Foods that control large parts of global food supply and marketing. These companies pressure small-scale farmers to invest in commercial crops, and later they pay the farmers a small fraction of the market price (LeClair 2002).

Unfair pricing, debts and poor access to markets challenge small-scale farmers in developing countries, and they are unable to negotiate with multinational companies to increase their income (Petchers & Harris 2008). Commercial farming however, also creates job opportunities for small-scale farmers and integrates them into transnational value-chains (Hall et al. 2017). Coffee is one of the most important cash crops in developing countries, and it employs and provides income for millions of small-scale farmers (Bacon 2010; Jaffee 2007). *Coffea arabica* (hereafter Arabica) and *Coffea canephora* (hereafter Robusta) are the most commonly produced coffee species in the world, and account for roughly 70% and 30% of the world production respectively (Fraser et al. 2014).

This study attempts to analyze how the production of coffee affects rural farmers in Nicaragua, a developing country in Central America. In Nicaragua, Arabica has been cultivated in the northern highlands since 1850, mainly in Matagalpa and Jinotega. Robusta, on the other hand, has only been produced on the Atlantic coast of Nicaragua (hereafter the Caribbean region) since 2005 (Castellón 2014b; Hilten 2012; MIFIC 2008) (figure 1). Arabica is a high-quality coffee sold to Europe and the United States, while Robusta is sold as instant coffee on the local market (Castellón 2014; Ovalle-Rivera et al. 2015). Numerous studies have explored how the production of Arabica impacts rural farmers in the north of Nicaragua (Bacon et al. 2008a; Bacon et al. 2014; Méndez et al. 2001; Wilson 2009), but the expansion of Robusta is recent

and there are no published studies on the production in Nicaragua. This study therefore attempts to fill the knowledge-gap on how the production of Robusta affects rural farmers.

COFFEE IN NICARAGUA

A historical perspective

Coffee has played a key political role in the Nicaraguan history since colonial times. European colonizers introduced coffee in 1850, and until the 1930s, most of the coffee was produced by small-scale farmers (Bacon 2008). In 1934, the political leader Anastacio Somoza led Nicaragua into nearly 50 years of dictatorship. He took over and centralized the coffee production, and turned small-scale coffee farms into large plantations that were controlled by a powerful elite. Consequently, the coffee farmers were forced to leave their land and work on large coffee plantations as *cafetaleros,* coffee harvesters (Wilson 2013).

In 1979, the Sandinistas (*El Frente Sandinista de Liberación Nacional)*, a socialist-inspired revolutionary group, came to power in Nicaragua. They re-organized the coffee plantations, returned the land to the *cafetaleros*, and established coffee cooperatives to facilitate coffee production and sale. Because they removed the well-established production system that had sustained the economy since Somoza came to power, the economy was at risk of collapsing. Violeta Chamorro, political leader of *Unión Democrática de Liberación* was elected as president in 1990, and she introduced neoliberal policies to promote economic growth in Nicaragua. The government therefore liberalized the economy, removed farm subsidies, and encouraged powerful investors to keep the coffee production and other high-value crops as cotton and sugarcane, on track (Biderman 1983; Wilson 2013).

Simultaneously as the political reforms, fair-trade organizations and companies that produce specialty coffee entered the Nicaraguan coffee industry (Bacon et al. 2008a). This enabled some farmers to export certified Arabica to a higher price than non-certified coffee. However, as only a few farmers joined this alternative development, most farmers were challenged by a liberalized market and powerful investors, resulting in low prices and competitive coffee markets in Nicaragua (Bacon 2008; Wilson 2013). From the time president Somoza removed the land of small-scale coffee producers, coffee has therefore remained a crop of the poor (Bacon et al. 2008a). The Nicaraguan coffee market is competitive and the coffee prices have

remained low. Therefore it was rather surprising when Robusta was introduced in Nicaragua in 2005.

The expansion of Robusta in Nueva Guinea

In 2005, a Nicaraguan coffee export company introduced coffee Robusta to Nueva Guinea, a municipality in the south Caribbean region (figure 1). As Robusta is of lower quality than Arabica, the government restricted that production to the Caribbean region to not threaten the Arabica plantations in the north (Castellón 2014). A Nicaraguan coffee export company, the Mercon group (hereafter Mercon) planted Robusta as a pilot project to test its suitability in Nueva Guinea. By 2007, they sold seedlings to local farmers and motivated them to invest in Robusta, and then to sell the coffee beans to *Empresa Comercial Internacional Agrícola* (hereafter CISA).

CISA is a branch of Mercon, and they coordinate the production of Robusta in Nueva Guinea. They sell coffee seedlings and chemical inputs, offer technical assistance to the farmers, and finally they buy the dried coffee beans. The coffee is then sold to Presto, a Central American branch of Nestlé and they make instant coffee from the coffee beans (Mercon 2016). The production of Robusta has expanded rapidly in Nueva Guinea, and in November 2016, over 200 farmers from 47 different communities had planted Robusta on nearly 900 hectares (ha) (CISA 2016).

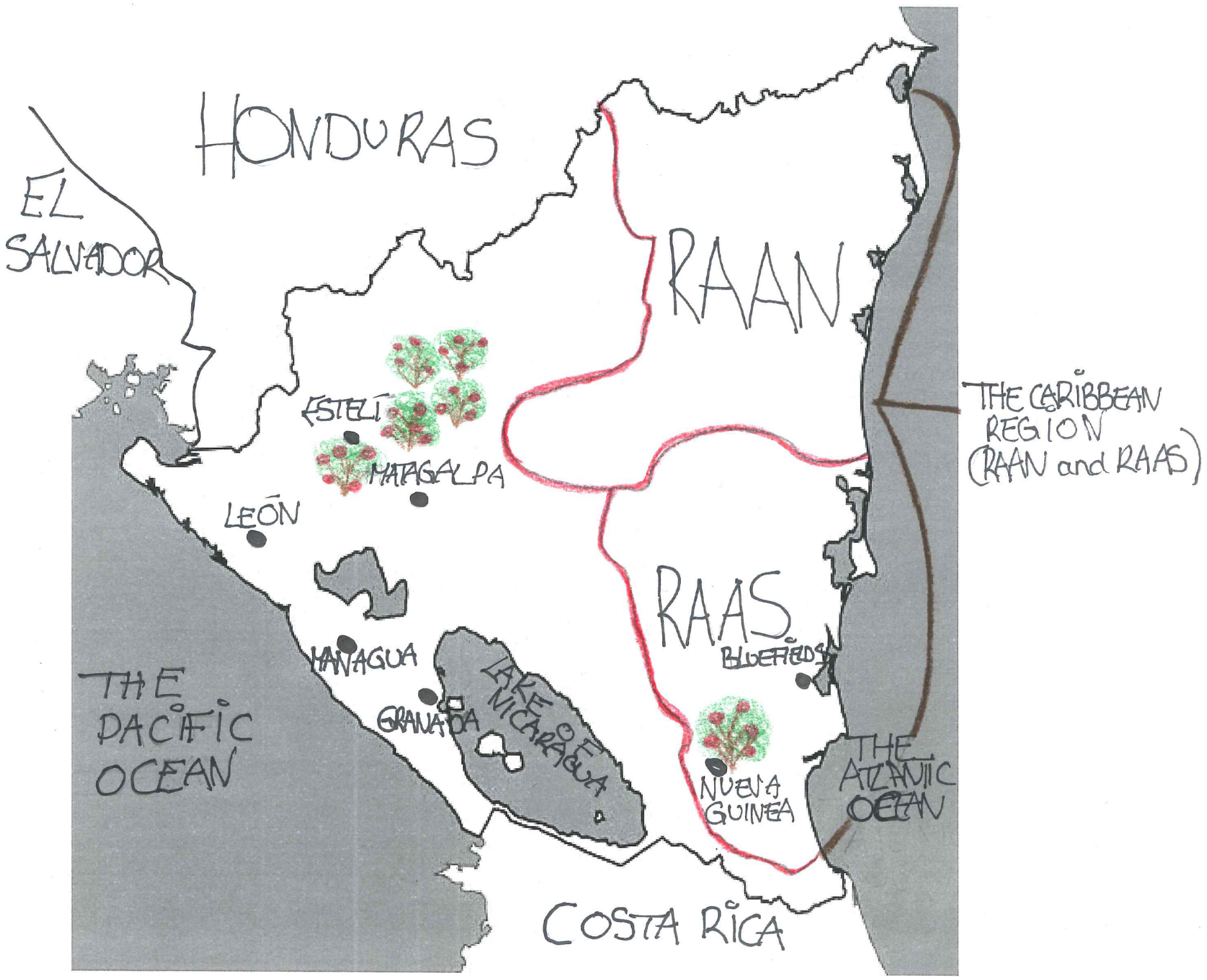

Figure 1: A map of Nicaragua. It shows the main coffee regions: Estelí and Matagalpa, the division between the autonomous Caribbean region: *Región Autónoma del Atlántico Norte (*RAAN) and *Región Autónoma del Atlántico Sur* (RAAS), including the municipalities of Nueva Guinea and Bluefields. The green coffee plants show the main coffee regions.

RESEARCH QUESTION AND OBJECTIVES

In my research, I aim to answer the following research question:

What are the socioecological impacts of the production of Robusta on the farming activities of rural farmers in the Caribbean region of Nicaragua?

My first objective is to analyze how the production of Robusta makes rural farmers change their farm activities. This includes the change of staple crops, trees and livestock that are important for both own consumption and sale. My second objective is to combine agroecological thinking and the sustainable livelihood approach (SLA) into a framework to evaluate the social and environmental sustainability of the production of Robusta in Nueva Guinea.

In the next sections, I introduce the theoretical framework for this study: the sustainable livelihood approach (SLA). Then, I use this framework to explain how historical events have shaped rural livelihoods in the Caribbean region of Nicaragua. This creates a base to understand how the production of Robusta affects rural livelihoods in Nueva Guinea. Further, I introduce the methods I used in the fieldwork I carried out in Nueva Guinea in October and November 2016. This includes my field observations, semi-structured interviews, and the data analysis. I present my results and discussion, where I connect my major findings to my research question. I then include studies from Brazil and Vietnam, the leading producers of Robusta, to understand the long-term effects of producing Robusta. Finally, I conclude with a future perspective on the production of Robusta in Nueva Guinea.

THEORETICAL FRAMEWORK

The sustainable livelihood approach

The sustainable livelihood approach (SLA) attempts to capture the complexity and diversity of the rural poor. It analyzes how people access and use their resources, and how this relates to social and environmental sustainability (Bebbington 1999; Chambers & Conway 1991). A livelihood can be assessed at the level of an individual, a household, a family or a village (Scoones 2009). Farming is one of the most important strategies of the rural poor in the tropics, along with seasonal migration and industrial work (Bebbington 1999). Rural livelihoods in Nueva Guinea are in the focus in this study, and using SLA as a theoretical framework enables a detailed insight into their resource base and how they make a living. A further elaboration of SLA is shown in Appendix 1. In the framework of SLA, resources uses of rural livelihoods are called capitals, and the capitals are divided into 5 categories: social, natural, financial, human and physical (Chambers & Conway 1991; Scoones 2009) (table 1).

Table 1: The 5 capitals, as described by Chambers and Conway (1991): natural, social, human, financial, and physical. I describe each capital in the table, with literature sources.

Capital	Description	Sources
Social	Social networks, relations and politics that are important to accomplish livelihood strategies.	(Ellis 2000; Nunan 2015; Scoones 2009)
Natural	Natural resources as water, genetic material of plants and animals for breeding, land, forests, and biodiversity.	(Ellis 2000; Nunan 2015; Scoones 2009)
Financial	Access to technology, markets, credits, and cash that are important to reach livelihood strategies.	(Ellis 2000; Nunan 2015; Scoones 2009)
Human	Skills, knowledge, and social services that are important to accomplish different livelihood strategies.	(Ellis 2000; Nunan 2015; Scoones 2009)
Physical	Access to infrastructure and technology, as roads, water, and schools.	(Cleary 2003; Ellis 2000; UN 2005)

The capitals in the context of Nueva Guinea

Social capital

Political reforms in the Caribbean region have shaped the social capital of rural farmers in Nueva Guinea. The municipality of Nueva Guinea was established in 1981, and is a part of the south Caribbean region (Magfor n.d). In 1987, the Sandinista government turned the Caribbean into two autonomous regions: The Autonomous North and South Atlantic Region (RAAN & RAAS) (figure 1). The minority groups pressured to get a division because they had been deprived and excluded from the central government since colonial times (Estrada 2013). This division therefore empowered the minority groups and enabled them to adapt national laws to the Caribbean context.

The political reforms in the Caribbean region was supplemented by large migrations, and this changed the social capital of rural farmers in Nueva Guinea. In 1971, only 9% of the 1,9 million Nicaraguans lived in the Caribbean region (INIDE 2005). Most of these were minority groups, but thousands of people migrated from the northern regions and the Pacific coast to the Caribbean region from the 1980s and onwards. These migrants came to the Caribbean region to invest in agricultural production and the population increased rapidly, challenging the minority groups (Magfor 2008; Sollis 1989). As the Caribbean region became autonomous at that time, the local leaders struggled to adapt new settlers to the Caribbean context. In 2005, the last population census, 14% of the 5,1 million Nicaraguans lived in the Caribbean region, and 54% of the 42 000 people in Nueva Guinea lived in extreme poverty, where their income was too low to cover their basic needs (Cuthbert & Alvarez 2014; INIDE 2005). Further, agricultural expansions were one of the reasons people migrated to the Caribbean region, and this has also changed the natural capital of Nueva Guinea.

Natural capital

Population growth and agricultural expansions have drastically reduced the natural landscape of Nueva Guinea. In the 1960s, president Somoza acquired large areas in the Caribbean region and invested in timber logging, together with crop and livestock production (CACRC 1998; Estrada 2013). The rich soils and tropical climate in Nueva Guinea enables intensive and year-round agricultural production of staple crops, such as maize (*Zea mays*), red beans (*Phaselous vulgaris*) and plantain (*Musa ssp*), in addition to livestock production (Acuna et al. 1992). Consequently, the natural capital of Nueva Guinea is the base for economic and social development, and the production of Robusta is also a reason for that.

Robusta is well adapted and produce large crops in the tropical climate of Nueva Guinea, and it has been planted extensively since 2005. With average temperatures between 22 and 30°C it grows up to 6 meters high, and is significantly more productive than coffee Arabica (Bunn et al. 2014; DaMatta et al. 2007). Robusta is a sun-tolerant plant, and as a perennial plant it can regenerate degraded soils (Clifford & Willson 1985; Schaller et al. 2003). CISA technicians in Nueva Guinea therefore recommends farmers to plant Robusta on former paddocks for livestock and unused land, to improve the soil quality of trampled land. The abundant natural

capital of Nueva Guinea is also the principal source of income and employment for the rural livelihoods.

Financial capital

The Caribbean is the poorest region of Nicaragua and this has challenged both agricultural expansion and rural development in Nueva Guinea (UNICEF 2015). In the 1990s, the government liberalized the economy to prosper economic growth of the agricultural sector. However, because agricultural expansions were led by a powerful elite, the rural farmers in the Caribbean region struggled to match these rapid expansions (Horton 2013; Spoor 1994). Most of the rural farmers in Nueva Guinea however, own agricultural land and they are self-sufficient with food. Agriculture is therefore the principal source for economic growth in the Caribbean region (Horton 2013).

Rural agriculture contributes with 19% of the national gross domestic product (GDP), and of the total rural agricultural production, the Caribbean region contributes with 54% (Torres 2008). Staple crops, such as maize, beans and plantain are important in the Nicaraguan diet, and 79% is produced by small-scale farmers (Magfor 2009). Cattle production was important during the Somoza regime and it has remained a major source of income in Nueva Guinea. The farmers in Nueva Guinea also produce root vegetables, as taro (*Colocasia esculenta*) and cassava (*Manihot esculenta*) for the national market. When Robusta was introduced to Nueva Guinea in 2005, the farmers could invest in a crop that is more profitable than the staple crops, and the production has prospered since.

Human capital

The social services in the Caribbean region have been poorly developed since the Somoza regime, and this has challenged rural livelihoods in Nueva Guinea. To improve the poor conditions in the Caribbean region, the Sandinistas implemented education programs for both children and adults (Arnove 1995). However, when the Caribbean region became autonomous and because the municipalities were poorly governed by the local leaders, it was difficult to maintain the education programs (Estrada 2013; Sollis 1989). Consequently, the levels of education and health services have remained below the national average (Franzoni 2013; UNICEF 2012).

Migrating people from the northern regions and the Pacific coast brought agricultural knowledge to the Caribbean region, and along with population growth, the government invested in education services in Nueva Guinea. El Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense (URACCAN) was established in 1995 and is the only public university in the south Caribbean region (RAAS). It offers higher education to rural communities, and this has strengthened the social and cultural unity in the region (F-ODM 2008). The migrants also brought knowledge about root vegetables and coffee, and these became important cash crops in the region (Suárez & Solis 2013). Education, economic development, and agricultural expansions therefore contributes to strengthen social services among rural people in Nueva Guinea.

Physical capital

The Caribbean region has suffered from conflicts and natural disasters and this has hampered the physical capital. After the Sandinista revolution, Nicaragua endured a ten-year civil war between 1980 and 1990. This war and the hurricane Mitch in 1998, one of the deadliest hurricanes in Central America, destroyed much of infrastructure in the Caribbean region (Suárez & Solis 2013). Despite this, the population of the Caribbean region kept increasing, and the government was pressured to restore and invest in infrastructure. In 2000, the government paved a road that connects Nueva Guinea and Managua, the capital, and this has facilitated migrations and the transport of agricultural products to the capital. The roads that connect the communities in Nueva Guinea however, are poorly developed and this restrict people to expand the agricultural production in the area (Estrada 2013).

The communities in Nueva Guinea lack proper access to water and sanitation services, and this is a major obstacle to develop the physical capital of the rural communities. In 2005, only 38% of the population in the Caribbean region had access to drinking water (F-ODM 2013). A study funded by the World Bank in 2007 showed that several communities still lacked sewage and water treatment systems (Castro 2007). However, in 2010, the Nicaraguan government made access to water a human right by law. This was then supported by a United Nations (UN)-funded project that targeted to half the population without access to drinking water in the Caribbean region (ANA 2010; F-ODM 2013). These initiatives have therefore increased the focus on proper basic infrastructure in the rural areas in the Caribbean region.

METHODOLOGY

The farms I visited in Nueva Guinea are both diverse and complex, and to get a holistic understanding of the farm systems I have combined agroecological thinking and the sustainable livelihood approach (SLA). Agroecology is a study that focus on the ecology of food systems. It analyzes internal and external social, ecological and economic dimensions of a farm system, to find innovative solutions that will enhance the farm's social and environmental sustainability (Francis et al. 2003). The production systems in Nueva Guinea are mainly family run; where they main source of food and income is from crop production and herding. I focus on the production systems at the farm level, where the farmers' experiences and opinions are in the center. To initiate this methodological section, I describe my experiences from the fieldwork in Nicaragua.

Experiences from the fieldwork

I arrived in Nicaragua in mid-October 2016, and had scheduled a one-month fieldwork. With help from the Research Centre of Tropical Agriculture (CIAT) in Managua, I contacted the main contact person in Nueva Guinea and finalized the interview plan in one-week stay. The manager of CISA, the main distributor of Robusta in the region, was the main contact person in Nueva Guinea. He gave me a list of the producers of Robusta in Nueva Guinea, then I listed all the relevant farmers, and with their help I identified the farmers that would be most relevant for my study. After one-week stay in Managua and the interview plan was ready, I traveled to Nueva Guinea for two weeks of data collection.

I stayed two weeks in the center of Nueva Guinea, a small city full of life from early morning to sunset. Different from Managua where the streets are filled with chaotic traffic, the center of Nueva Guinea has little motorized traffic. There are numerous street-shops along the road, where people combine food sale with sales of clothes, pharmacies and even chemical products for agriculture. Outside the city center however, the scene is very different. The infrastructure is poor and agricultural fields and small households dominate the area.

During my two weeks in Nueva Guinea, I interviewed farmers at the main office of CISA, and the CISA staff took me to nearby communities to meet the farmers in their houses. The farmers we met were open to talk, and this is probably because of the well-established relationship with CISA. I talked informally with the farmers along with the interviews, and this laid the

foundation for a gradual understanding of how the farmers make a living in Nueva Guinea. Most of the farmers I interviewed own land far from where they live, and because they would initiate the harvest season in three weeks, I met the farmers in their homes.

The communities are relatively small and most have a village center of 20 to 30 houses. A village center like this typically has numerous churches, a big park, eateries and small shops. The houses people live in are simple cement constructions painted in bright colors. Each house has a principal room with a television, a bedroom and an outdoor kitchen at the back of the house. All the houses have a garden with small plots of crops and decorative plants.

As we traveled around to the different communities, I observed a green and lush landscape and dispersed fragmented forest patches. There are large areas of paddocks, and the CISA staff said that livestock production is an important source of income in the region. Along with coffee plantations, I observed mainly plantations with cacao, cassava, maize, root vegetables, pineapple and papaya. During these field experiences and through informal talks with my main contact person in CISA, it became clear that farming is the main activity in the region. With the interviews, it created a base to understand how rural farmers adopt various livelihood strategies to make a living.

Interviews

Based on a list given by CISA in Nueva Guinea, I selected 36 of the 200 Robusta farmers in Nueva Guinea. I selected the farmers for the interviews based on how long they had grown Robusta, and I selected 36 farmers because this was the number I could complete within 2 weeks (table 2). Of the 36 farmers, 30 had planted Robusta between 2007 and 2013. The remaining 6 producers planted between 2014 and 2015. A varied sample ensured a sample of experienced farmers, and a complementary sample of farmers who had planted more recently. Figure 2 shows the communities I interviewed in Nueva Guinea.

I presented an ethical declaration before I initiated the interviews to inform the interviewees about the background of this study. I also explained how I would use the information from the interviews (Appendix 2). I told them about the motivations to conduct this research and about my expectations. I also explained how their opinions and experiences with Robusta were a major part of my research. I asked about their farm activities, but I did not ask about their

incomes. The interviewees were mostly men, as seen in table 2. If I had interviewed both men and women in each interview it might have changed the responses. This is because women and men have different roles on the farms in Nueva Guinea.

I have also excluded the names of the interviewees and generalized single case scenarios because their names are irrelevant for this study. Names as Pedro, José and Miguel are therefore fictive names. The names of the companies that are involved in the production of Robusta, such as Mercon, CISA and Nestlé are real ones, and I have included these to facilitate future research.

Table 2: An overview of the interviewed farmers, with farm names and gender of the interviewed farmers (M= male, F= female), the name of the communities and the total productive area of the farms (hectares)

Farm	Farm name	Community	Total area (ha)	Farm	Farm name	Community	Total area (ha)
1	El Coco (M)	Los Ángeles	7	19	Buena Vista (M)	Los Ángeles	26
2	El Trillo (M)	Nueva Guinea	14	20	El Diamante (M)	Yolaina	17,6
3	Bella Vista (F)	Yolaina	14	21	Monteverde (M)	Yolaina	8,8
4	La Esperanza (M)	La Esperanza	35,2	22	La Flor (M)	Nueva Guinea	49,3
5	San Antonio 2 (F)	San Antonio	28,1	23	El Coco (M)	Los Pintos	17,6
6	El Diamante (M)	San Antonio	59,1	24	El Torno (M)	Nueva Guinea	140,8
7	El Copito (M)	San Antonio	21,1	25	El Coyolote (M)	Los Pintos	23,2
8	La Esperanza (M)	San Antonio	35,2	26	La Unión (M)	Los Pintos	3,5
9	El Destino (M)	Guinea Vieja	42,2	27	Regalo de Dios (M)	Yolaina	14
10	La Ceiba (M)	Guinea Vieja	3,5	28	Pinaré de Rio (M)	Nueva Horizonte	70
11	San Martín (M)	Los Ángeles	7	29	La Unión (M)	Los Pintos	84,5
12	La Perla (M)	Los Pintos	28,1	30	La Esperanza (M)	La Esperanza	35,2
13	San Antonio (M)	Los Pintos	211	31	La Recia (M)	Yolaina	17,6
14	La Fortuna (M)	Montevideo	17,6	32	Santa Elena (M)	Los Pintos	13,3
15	Buenos Aires (M)	Montevideo	35,2	33	San Antonio (M)	La Esperanza	10,5
16	La Belleza (M)	Montevideo	7	34	Nueva Guinea (M)	Nueva Guinea	7
17	Los Ángeles (M)	San Roque	188,7	35	Dos Hermanos (M)	Los Pintos	46,4
18	Lo Alpez (M)	Nueva Guinea	88	36	Bella Vista (M)	Los Pintos	7

Questionnaire

I initiated the conversations with the farmers with a questionnaire to "set the stage", and to get an overview of their farm activities. The CISA staff were present during the interviews, and knowing that this possibly would affect the conversations with the farmers, I chose not to record the interviews in case this would influence the interviews more. The questionnaire includes questions on crop types, including their uses and management. I asked them to list the three major crops that were most important for sale and own consumption. Finally, I asked if they applied organic or chemical treatments on the crops they produce. I filled in the interview forms in the interviews, as shown in Appendix 3a. I then continued the conversation with a semi-structured interview, where I brought in social, economic and ecological aspects of their farm activities (Bernard 2006; Walliman 2006).

Semi-structured interview

My objective with conducting a semi-structured interview was to be a participant observer and to learn from the producers (Bernard 2006). I therefore asked how many people where in the household, and the household's role on and outside the farm. To quantify the diversity on the farms I asked whether they had trees and animals, and how these are managed on the farms. I asked how they manage pests and diseases on the Robusta plants. Then I asked how the soil structure and productivity of the Robusta plants and other crops have changed since they planted the Robusta plants. To include the socioeconomic aspects of Robusta, I asked about its costs and profits, whether they will continue to grow Robusta, and what they would have planted instead of Robusta. Finally, to sum up the interviews I asked if they recommended Robusta to other farmers in the region, and I asked about how they foresee the Robusta production in the next five to ten years. An example of a semi-structured interview is shown in Appendix 3b.

At the end of the fieldwork, I interviewed two contact persons that are involved in the production and sales of Robusta in Nueva Guinea: the manager of CISA in Nueva Guinea and an employee of Mercon in Nueva Guinea. These interviews were based on the findings from the interviews I had conducted with the farmers. I asked about what motivated Mercon to invest in Robusta in Nueva Guinea, and in what ways their expectations matched the reality. Then I asked about how they motivate farmers to plant Robusta, and if they receive feedback from the farmers. Finally, I asked how Robusta has changed the landscape of Nueva Guinea.

Figure 2: A map of the communities in Nueva Guinea. The communities I conducted the interviews are circled in red (Miguel 2016).

Data analysis

I divided the analysis into two parts: quantitative and qualitative. To identify the major and most relevant findings from the interviews, I combined the 5 capitals of SLA and agroecological thinking. The next sections summarize the quantitative and qualitative analysis. Then I explain how I have interpreted the findings in relation to a Robusta-centered livelihood analysis, and this is the base to analyze the livelihood security and environmental sustainability of Robusta in Nueva Guinea.

Quantitative analysis

In the quantitative analysis, I identified and mapped the farm management and diversity of the farms I studied. The quantitative analysis was carried out to get an idea on the diversity, farm activities and family composition on the farms (Bernard 2006; Walliman 2006). To compare the different farms in relation to the total farm size, I categorized the farms into 3 groups according to their total productive area: small, medium, and large. Then I categorized the agricultural inputs as either chemical or organic. The chemicals include fertilizers, herbicides, fungicides, and pesticides bought on the market, while the organic group include treatments such as manure, compost, weeding, insect traps, and organic fertilizers, herbicides, fungicides,

and pesticides bought on the market. I quantified the management of the Robusta plants, and this includes how the soil quality, productivity, pest, and disease incidents have changed the last five years.

Qualitative analysis

I analyzed the qualitative data in a table that lists my major findings. I made summaries of all the interviews during the fieldwork, and later I interpreted the major findings from the interviews and included these in a table (Appendix 4). In this table I categorize each farm, (1, 2, 3, and so on.), with the material from the interviews. This enabled a clear overview of my major findings and these findings are the base for the results.

I adapted a livelihood analysis developed by Ellis (2000) and inspired by the SLA framework, to the context of this study. Table 3 shows a Robusta-centered livelihood analysis based on the 5 capitals and the context these capitals are accessed. In the context of the production of Robusta in Nueva Guinea, the farmers access Robusta through social relations, markets, and state agencies, while in the context of macro policies, the capitals are accessed through market prices and trends. This has different effects on rural farmers in Nueva Guinea, as listed in the last box of the table. The livelihood analysis is the base I use to analyze the livelihood security and the environmental sustainability of Robusta in Nueva Guinea.

Table 3: A Robusta-centered SLA framework for livelihood analysis, inspired by Ellis (2000) and adapted to the major findings in this study.

Livelihood platform	**Accessed by**	**In the context of**	**Resulting in**	**Composed of**	**With effects on**
Natural capital Social capital Financial capital Human capital Physical capital	Social relations Markets in practice State agencies	Macro policy Relative prices National and world economic trends	Livelihood strategies	**Cultivation of Robusta** Other livelihood strategies	<u>Livelihood security:</u> *Income level* *Seasonality* *Degrees of risk* *Savings* <u>Environmental sustainability:</u> *Soils and land quality* *Water* *Rangeland* *Forests* *Biodiversity*

RESULTS

I divided the farms into 3 groups: small, medium, and large, according to their total productive area. Table 4 shows each category, the number of farms within each category, and the average farm sizes in hectares (ha). The table also lists the average production of the most produced staple crops: maize, red beans, plantain, and cassava. On average, small farms use 70% of their land to produce the 4 staple food crops, while the medium and large farms use 30% and 17% respectively. The remaining land area on each farm is used either to grow Robusta or paddocks for livestock production.

Table 4: The table shows how I divided the farms into 3 categories (small, medium, and large) according to their total productive area, including the number of farms, area of crops, and the average area of Robusta production according to each category.

Category:	Small farm	Medium farm	Large farm
Size distribution:	3,5 – 10 ha	10 – 30 ha	< 30 ha
N^{o} of farms:	8 farms	14 farms	14 farms
Average farm size:	6,4 ha	18,8 ha	80 ha
Area of crops:	Maize: 1,2 ha Beans: 1,1 ha Cassava: 1,5 ha Plantain: 0,6 ha	Maize: 1,3 ha Beans: 1,3 ha Cassava: 2,3 ha Plantain: 0,8ha	Maize: 2,7 ha Beans: 2,4 Cassava: 2,8 ha Plantain: 1,6 ha
Average area of Robusta:	3,5 ha	6 ha	13,5 ha

Farm activities

The farmers I interviewed in Nueva Guinea are engaged in diverse farm activities, and they depend on crops, trees, and animals for both income and food. Of the 36 farmers I interviewed, 25, or 70% grow between 4 and 6 crops, namely maize, red beans, cassava and plantain, and some farmers grow rice (*Oryza spp*), and taro (*Colocasia esculenta)* in addition to the 4 mentioned staple food crops. Of the 36 farmers, half of them have between 5 and 7 fruit and timber trees, while 10 farmers have more than 8 trees on the farm. In total I registered 17 different tree species in all the interviews.

All the 36 farmers have livestock, and on average they have 3 livestock per farm. Of the 36 farmers, 70% have cows, while 64% have chickens and half of the farmers have pigs. The farmers said that the cows and pigs are principally sold on the local market and provide an important income to the households. The chickens however, generate little income and are therefore mainly consumed within the household.

Socioecological aspects of Robusta

CISA sells a Brazilian bred hybrid of Robusta called *Conilon* to the farmers in Nueva Guinea. This hybrid is bred to be a sun-tolerant, productive and resistant version of coffee Robusta (CISA 2016). Because of this adaptation, CISA recommends the farmers to plant Robusta in open fields with no tree cover, preferably on paddocks previously used for livestock. Despite these advices, 15 farmers kept the tree cover when they planted Robusta. Of these 15, 1 farmer planted Robusta in a closed forest system, while the remaining 14 farmers kept timber and fruit trees in the area they planted Robusta. The interviewed farmers said that they keep a wide range of fruit and timber trees because they depend on a variety of tree species for food, including timber and wood supplies for sale and own use.

The area the farmers grow Robusta on varies significantly between the 3 categories. As seen in table 4, Robusta occupies on average 3,5 ha, or 55% of the total land of small farms, while medium farms grow on average 6 ha, or 32%, and large farms 13,5 ha, barely 17% of their total land. The reason that this does not match the area used for crop production (table 4), is because some farmers planted Robusta recently and they intercrop food crops with Robusta plants the first years of production. This means that the area with Robusta is correct, while the area for food crops varies according to when they planted Robusta. Of the 36 interviewed farmers, 17 planted Robusta on cropland. These farmers produced staple crops where they planted Robusta. Of these 17, 7 are small farms and they produce Robusta on land they previously used to grow food crops. This is because their total productive area is too small to combine both profitable yields of Robusta and to be self-sufficient with food crops.

The farmers intercrop food crops with Robusta the first 2 to 3 years of production, and they also plant food crops after they pruned the coffee plants after 5 years. As food crops combined with Robusta yield more than crops grown alone, due to the extensive use of fertilizers on Robusta, it motivates farmers to take advantage of the land. When the Robusta plants reach maximum height however, most farmers stop to grow annual crops with Robusta because the coffee plants are too large and because CISA advised them to grow Robusta without other plant species. Some however, grow plantain within the coffee fields, because these plants grow close to the height of the Robusta plants and the coffee plants cannot outcompete the plantain plants.

Socioeconomic aspects of Robusta

The farmers said that they were motivated to plant Robusta because of its positive properties and because they got a higher profit than selling staple crops. Of the 36 farmers, 22 had been introduced to Robusta by CISA, while the remaining 14 got to know about it from other producers. Most of the farmers saw that Robusta was a resilient plant and that it created a forest-like environment. This motivated them to contact CISA to know more about the Robusta plants and how they could invest in the production. CISA then told them about the start-up credits, the high profit and the free technical help. All the farmers were in contact with CISA to initiate the production, and CISA finally persuaded them to initiate the production. Seeing that Robusta produced well after three seasons and that the other producers earned well, they continued to plant on new areas.

The farmers said that Robusta, cassava, and maize are the most profitable crops. CISA informed me that Robusta produce 600kgs dried beans per ha. Consequently, with a price of $215/100kgs, the farmers earn between $4515 (small farms) and $17415 (large farms) (CISA 2016; WB 2017). In contrast to maize, that yields 800kgs/ha, the profit is much lower. In 2016, the average price of maize in Nicaragua was $53/100kgs. Consequently, the farmers earned between $460 (small farms) and $972 (large farms). Cassava yields 1300kgs/ha, and with a price of $45/100kgs in 2016, the farmers earned between $585 (small farms) and $1260 (large farms) (USDA 2016). Maize is one of the most important staple grains in Nicaragua, while cassava is an important cash crop. Other crops, such as beans and plantain are mainly part of the household consumption or shared between neighbors. Despite the high profit of Robusta, the farmers therefore kept a diverse crop production to cover their dietary needs.

The production of Robusta improves the income for the farmers in the area and decreases the pressure to migrate out of Nueva Guinea. The profit from producing Robusta is significantly better than the profit from producing food crops and livestock. This motivates farmers to increase the amounts of chemical inputs to increase the yields. Some of the farmers organize meetings with other Robusta producers in the nearby communities, and this way they share experiences and knowledge on the Robusta production. The production of Robusta also creates local employment opportunities for coffee harvesters who earlier used to travel to Costa Rica to work on coffee plantations. The farmers said that CISA guarantees that they will buy the coffee yields and this is what motivates the farmers to plant Robusta. The farmers, however, emphasized that producing Robusta was a costly investment.

The production of Robusta is costly and the farmers said that they are the sole bearers of these costs. On average, each farmer spends 50% of the income of the Robusta production on chemical inputs, labor, transport, and processing, and they said that these costs are a large part of their income. Of the 36 farmers, 31 employ between 10 and 150 people to harvest coffee, while 5 farmers use only family- members during the harvest. CISA buys processed coffee beans, and the farmers must pay for both transport and processing of the beans before they sell them to CISA. CISA however, offers loans to the farmers so they can cover the major expenses to produce Robusta, and then the farmers can repay with the income from the processed coffee. This study did not include the income of the farmers, but 2 farmers said that Robusta did not generate profit after 5 years of production because the expenses to produce Robusta where too high.

The management of Robusta

All the farmers I talked to use chemical fertilizers on Robusta, while some also employ alternative techniques. The farmers buy chemical fertilizers directly from CISA or on the local market in Nueva Guinea. They primarily fertilize Robusta, but some farmers added fertilizers to the other crops as well, except for plantain because they consume it within the household, and it has little economic value compared to other staple crops. The farmers said that they increase the quantity of fertilizer every season; because CISA told them that the productivity of Robusta correlates with the quantity of fertilizer added.

The farmers employ alternative management techniques to reduce the costs of chemical fertilizers. Of the 36 farmers, 12 use cow manure as fertilizer in addition to chemical fertilizer. These farmers increased the quantity of manure as fertilizers on Robusta every season because it was cheaper than the chemical fertilizers. Of these 12, 9 have cows on the farm, while the remaining 3 buy manure from neighboring farms. Further, of the 36 farms, 9 fertilize Robusta with compost material. These are also the most diverse farms, where 7 have between 4 to 6 crops and the remaining 2 farms have more than 7 crops.

The farmers employ various techniques to reduce harmful pests and diseases. The coffee berry borer (*Hypothenemus hampei*) and coffee leaf rust (*Hemileia vastatrix*) are the most aggressive insect and fungal disease on Robusta in Nueva Guinea. The farmers use endosulfan and copper

to fight the leaf rust and berry borer respectively. However, as endosulfan is illegal, some farmers try out alternative techniques to control outbreaks. They harvest fruit and leaf residues after each season to prevent further attacks, and they have tried alcohol traps to prevent the berry borer from attacking ripe coffee fruits. Some farmers spray spores of the fungus *Beauveria bassiana* on Robusta to control outbreaks of the berry borer, but in the interviews, they did not say how the fungus control pest outbreaks. Finally, one farmer sprays fermented cinnamon on Robusta plants, and he said that it was efficient to reduce pest outbreaks.

DISCUSSION

The farmers and their production systems are in focus in this study. To relate the major findings to my research question, I combine my major findings with relevant literature to discuss my arguments, and to evaluate the social and environmental sustainability of Robusta.

I list the major findings in the Robusta-centered livelihood analysis as shown in table 3 from the method section (table 5). In this table I list the 5 capitals and how the rural livelihoods access these in Nueva Guinea. Then I list the actors that are involved in the production of Robusta in Nueva Guinea: Mercon, Nestlé and CISA, and in the last column of the table I list how Robusta affects the livelihood security and the environmental sustainability of the production systems of rural livelihoods in Nueva Guinea.

Table 5: Schematic presentation of Robusta as a livelihood strategy in Nueva Guinea. The last box "With effects on" shows how Robusta affects livelihood security and the environmental sustainability of Nueva Guinea, both positive and negative.

Livelihood platforms	**Accessed by**	**In the context of**	**Livelihood strategies**	**With effects on**
<u>Natural capital</u> - Rich soils - Favorable climate - Average land area: 6,4 to 80 hectares <u>Social capital</u> - Well-functioning relationships between farmers - Knowledge-sharing - Migrations - Autonomy <u>Financial capital</u> - 54% live in extreme poverty - CISA offers credits - Robusta is an expensive crop <u>Human capital</u> -Farmers with knowledge on coffee - Nestlé offers training courses on Robusta - RAAS University <u>Physical capital</u> - CISA provide transportation and processing of the coffee - Well-functioning road between Nueva Guinea and Managua - Poorly developed roads between the communities	Nestlé (Presto soluble coffee) Mercon group CISA agro in Nueva Guinea	Trends Migration International market International prices	**Cultivation of coffee Robusta (*Coffea canephora*)** Food crop production Milk and meat production Pig, chicken and sheep production Cacao production	<u>Livelihood security:</u> Positive: *-Improves income for rural livelihoods* *-Increases employments opportunities* *-Less migration to Costa Rica* *-Secure buyer (CISA)* Negative: *- Insecurity: one yield per year* *- Sellable yields after 3 years* *- Costly inputs (fertilizers, herbicides, pesticides)* *-One buyer of Robusta* *-Credits: loans and debts* <u>Environmental sustainability:</u> Positive: *- Diversifies some farm systems* *-Reforest paddocks* *-Resilient plant* *-Prevent soil erosion (perennial plant)* Negative: *-Chemical pollution from inputs* *-Grown in one-crop system* *-Requires open areas (no shade)* *-Motivate tree-cutting*

Livelihood security and Robusta

The farmers have increased their incomes with the production of Robusta, but the rapid expansion of that production also challenges the traditional farm activities. A livelihood is secure if they have sustainable access to income and resources to meet their basic needs (Ellis 2000; FAO et al. 2017). Producing Robusta contributes with an additional income, but it is also a risky and costly investment to the farmers. The farmers in Nueva Guinea however, employ diverse farm activities and strategies to cope with the risks and to reduce their vulnerability.

Diverse farm systems

The farmers in Nueva Guinea are engaged in diverse farm activities, and the diversity of crops, animals, and trees they produce creates a resilient and rich farm system. Because the farmers are self-sufficient, the diversity of food sources is essential for their food security. According to the World Food Summit (1996), food security exists when people have economic and physical access to safe, sufficient, and secure food to meet their dietary needs (FAO 1996; Sunderland 2011).

After they planted Robusta, 31 out of 36 farmers kept a diverse farm system, with animals, staple crops, fruit, and nut trees. Maize, beans and plantain are staple crops in Nicaragua, along with chicken and pigs (Magfor 2009). Cassava and taro are mainly sold on the national market, because these are the most valuable food crops to the interviewed farmers, and have recently become an important commercial crop in the region. Even if producing Robusta generated significantly more income than the other crops, it is inedible and does not secure the local farmers' food supply. The diverse food sources are therefore essential to cover their basic needs, and with this security as a base they invest in Robusta.

If the farmers combine Robusta plants with other plants species it could increase the resilience of farm systems in Nueva Guinea. The farmers said that extreme weather events have challenged their farm activities the past years. Staple crops and Robusta are sensitive to droughts, floods and high temperatures - and it has become more difficult to grow these crops in Nueva Guinea, as well in other tropical regions (IPCC 2014; Tscharntke et al. 2012). However, an integrated production system with annual and perennial crops, combined with trees can create a resilient farm system – in contrast to a low-diversity system that is vulnerable to harmful environmental changes (Lin et al. 2008). Therefore, an integrated system with

Robusta, annual crops and trees can buffer climatic changes, as higher temperatures, extreme droughts and rains (IPCC 2014). However, even if most farmers have a diverse and resilient farm system, one group is especially vulnerable.

Small farms are vulnerable

The production of Robusta challenges the farm activities of small farms, and if Robusta fails it makes them substantially more vulnerable than medium and large farms. Most of the small farms planted Robusta on land they previously used to grow food crops, and this reduce their food security. The small farms are also vulnerable if a crop fails, compared to the medium and large farms, because they have planted Robusta on over half of their land. However, all the farmers intercrop food crops with Robusta plants to reduce this vulnerability.

To take advantage of the open areas on the newly planted fields of Robusta, the farmers intercropped food crops with Robusta the first years of production. This was an important strategy to use the full potential of the land and to provide sufficient food to the household. Combining Robusta plants with annual crops is a strategic way to utilize the total productive area. Annual crops as maize, beans and cassava benefit from large fertilizer applications, and the organic residues from the annual crops benefit the soil biota. Leguminous plant species, as clover, beans and peanuts can improve soil biota and fertility because their root systems are associated with mycorrhiza, a beneficial soil fungus (Altieri 1999). Further, Robusta affects the economy of the livelihoods in Nueva Guinea.

Costs and profits of Robusta

The production of Robusta improves the livelihood security of the farmers in Nueva Guinea, but because it is a costly investment it imposes a great risk for the farmers. Compared to staple crops, Robusta is significantly more profitable. Producing Robusta reduces migrations and generate local employment to the farmers who do not produce Robusta. However, most farmers must take up loans to cover the major expenses of Robusta. Even if they access credits through CISA, but the productivity of Robusta is too low to cover the expenses, they are still forced to pay back the loans to CISA by selling of parts of their land or use their savings (CISA 2016). Consequently, though Robusta is a profitable crop because it pays better than staple crops, the farmers said that the production imposes a great risk.

CISA motivates farmers with high profits and productive Robusta plants, but the high expenses challenges the farmers. CISA offers free technical assistance and monitors the farmers during the production cycle of Robusta. A representative from Mercon said that the productivity of Robusta correlates with the chemical fertilizer applications, and most farmers invest in large yields (CISA 2016). Consequently, the farmers are pressured by CISA to invest a lot of money to get a high profit. This place them in a vulnerable position if Robusta fails and they cannot pay back the loans.

Some of the farmers organize regular meetings with other Robusta producers in nearby communities, and they share experiences and knowledge on the Robusta production. As some of the farmers are originally from northern Nicaragua, they are experienced coffee producers and this enables some farmers to access knowledge on how to produce coffee in alternative ways than to depend on the advices from CISA. The farmers also suggested that other companies should also invest in the production of Robusta to challenge the monopsony of CISA and reduce the farmers' vulnerability.

Who bears the risk?

CISA is the only buyer of coffee in Nueva Guinea, and this makes the farmers vulnerable. CISA controls the production of Robusta and offers everything from seedlings, chemical inputs and transport of the coffee fruits. Therefore, the farmers depend on CISA from planting to sales, but the farmers are responsible if the production fails or if CISA stop to purchase Robusta. In 2005, over half of the people in Nueva Guinea lived in extreme poverty and the Caribbean region is poorly governed. Though the farmers receive free technical assistance through the whole production cycle, they live in insecurity regarding the future because none other than CISA monitors the production. The farmers are therefore themselves responsible if the production fails.

Robusta is funded by the private sector and this challenge the security of the farmers. Since Nicaragua liberalized the economy in the 1980s, private investments have supported economic growth and enabled agricultural expansions in the region (PNDH 2012; Spoor 1994). In Nueva Guinea, CISA offers credit schemes to the farmers, and this enables them to invest without start-up capital. However, it is unclear how the government assists the farmers if they fail to pay back the loans to CISA. A study from northern Nicaragua shows that the coffee producers

are bound to debts and low incomes because the government has failed to assist them when the price is low (Wilson 2009). Similarly, the farmers in Nueva Guinea are exposed to a highly fluctuating coffee market, and they depend only on CISA to finance Robusta.

The farmers in Nueva Guinea are involved in the international coffee market through the production of Robusta, and this both empowers and challenges them. The farmers are bound to CISA through contract farming. Contract farming is an agreement between an enterprise and a producer to facilitate the sale of agricultural products, such as coffee, on the international market (Eaton & Shepherd 2001). In Nueva Guinea, this implies that the farmers are committed to sell their yields to CISA at a price determined by the London Stock Exchange. Though the farmers are secured sales every season, contract farming is challenging because they are bound to a highly variable international coffee market (ICO 2017). In November 2016, CISA paid $2,3 per kg of dried Robusta beans. The price of Robusta is much lower than Arabica, at $4 per kg of dried beans, and even if the price of Robusta fluctuates through the year and they could sell the coffee beans when the price is high, the interviewed farmers in Nueva Guinea are forced to sell the harvest because they lack storage facilities on the farms.

The environmental sustainability of Robusta

Robusta plants are a major part of the landscape in Nueva Guinea, and therefore it affects the environmental sustainability and biodiversity in the region. Environmental sustainability exists when natural resources are used in a way that preserves the natural diversity of ecosystems and ensures future generations with enough resources to meet their basic needs (Brundtland 1987; Goodland 1995; Morelli 2011). The next sections explore how the production of Robusta enhances and challenges the environmental sustainability of the landscape in Nueva Guinea.

A landscape perspective on Robusta

CISA recommends farmers to grow Robusta on plots without other crops, but near half of the farmers I interviewed oppose this advice and produce Robusta with other plant species. Nearly half of the farmers I interviewed produce Robusta in an agroforestry system, which is a farm system that combines diverse crops, livestock and woody perennials (De Beenhouwer et al. 2013; Somarriba 1992). In Nueva Guinea, farmers combine Robusta plants with annual crops, fruit, and timber trees. Figure 3b shows a farming system in Nueva Guinea, where Robusta was combined with citrus trees. In contrast, Figure 3a shows how Robusta typically grows– with no

shade cover or other crops. That near half of the farmers in my study grow Robusta in an agroforestry system despite the recommendations from CISA, shows that biodiversity is important for them. A biodiverse production system has positive effects on species richness (Tscharntke et al. 2012).

From an ecological perspective, coffee agroforestry systems provide a shelter for numerous organisms, which in return benefit the agroforestry system. The diverse coffee systems in Nueva Guinea creates a shelter for birds, arthropods and mammals that contributes with functional diversity. Perfecto et al. (2014) showed that coffee agroforestry systems in Central America attracts soil organisms that benefit nutrient cycling, and are important food sources for migrating birds that feed on the berry borer (Perfecto et al. 2014). The density of pollinators increase with plant diversity, and a study from Indonesia showed that honey-bees increase yields of Robusta (Klein et al. 2003). These studies suggest that a diversified system with Robusta can benefit diverse organisms.

Figure 3a (left) and 3b: The pictures display 2 distinct production systems of Robusta in Nueva Guinea, where 3a shows an open landscape with only Robusta plants and few trees, while 3b shows an example of a diversified production system, with Robusta plants combined with citrus trees and a diversity of annual crops.

Changes in soil quality and structure

CISA said that the production of Robusta has revegetated the landscape and that the Robusta plants regenerate degraded fields in Nueva Guinea. Most of the farmers planted Robusta on paddocks previously used for livestock. They said that the organic matter of the Robusta plants makes the soil more porous, humid and fertile than annual crops and open paddocks. In contrast to what CISA said, the farmers believe that the extensive use of chemical fertilizers improves

the soil quality and not the Robusta plants themselves. All the farmers removed the organic material, as fruits and leaves from the Robusta plants to avoid pest and disease outbreaks in the following season. The farmers therefore left little organic matter from the Robusta plants that would benefit the soil fauna. The extensive use of chemical fertilizers, however, negatively affects the nearby environment.

The exposure to chemical fertilizers

The productivity of Robusta is driven by heavy chemical inputs and this challenge the long-term sustainability of Robusta. CISA technicians recommends the farmers to apply large quantities of chemical fertilizers to achieve high yields (CISA 2016). The intense use of chemicals on the Robusta plants however, reduces soil structure and quality in the long-term and toxify the nearby water sources with chemicals (FAO 2002; Savci 2012).

The farmers in Nueva Guinea re-use fertilizer bags to store dried maize and rarely use protection when they apply the chemical fertilizers on the Robusta plants. If humans are exposed to high concentrations of chemical fertilizers it has direct negative health effects (Adelana 2005). Nitrate, a nitrogen compound, is widely used in chemical fertilizers because plants easily take it up. However, because of its reactive form it is commonly transported in ground water systems and it can have severe negative health effects (Hord & Conley 2017). Large concentrations of nitrate can cause birth defects, cancer and hypertensions to humans, and it can be harmful to livestock (Adelana 2005). The farmers in Nueva Guinea however, also employs alternative practices.

Alternative fertilizers reduce chemical pollution

Some farmers in Nueva Guinea apply organic fertilizers and this improves soil fertility and structure. Compost and livestock manure are excellent nutrient sources for soil biota, and this has positive long-term effects on the sustainability of Robusta. Microbial, fungal and earthworm activity increases with organic applications (Abbott & Murphy 2007; Altieri 1999). Because Robusta is a perennial plant, the stable environment creates a habitat for numerous soil organisms (DaMatta 2004). Some farmers apply organic fertilizers and this improves the soil quality in the long term because they reduce the amount of chemical fertilizers on Robusta and the other crops. Pest and disease management, however, challenges the sustainability of Robusta.

The impacts of chemical pest management

The farmers combine two toxic chemicals to control outbreaks of insects and fungi on the Robusta plants. Most of the farmers use endosulfan to prevent insect outbreaks, and copper to prevent fungal attacks. The farmers said that these applications are effective against the berry borer and leaf rust that attacks Robusta. However, the United Nations (UN) Stockholm convention banned endosulfan in 2011, and it is illegal in Nicaragua (UNEP 2011). Although the farmers are aware of this ban, some farmers said they still access it through Honduras or other suppliers in Nicaragua. In contrast, copper is legal, and the farmers used it as fungicide and to control ant outbreaks on Robusta. This was efficient as it "*kills everything on and around the Robusta plant"* (José 2016). However, endosulfan and copper have severe negative consequences on human health.

The farmers apply endosulfan and copper on Robusta, and this has negative effects on human health and the surrounding environment. Endosulfan harms the nervous system and is immediately toxic if inhaled by humans (EPA 2002). The farmers in Nueva Guinea are exposed directly to the chemical when they apply endosulfan on the Robusta plants, and when they consume the food crops sprayed with endosulfan. Further, they are indirectly exposed because endosulfan enters the water system and is taken up in the drinking water (ATSDR 2015). Studies show that copper can have harmful effects on humans because it irritates the intestine system, causing diarrhea (ECHA 2014). It also have environmental effects, where it reduces the amounts of earthworms in the soils, negatively affecting soil biota and fertility (Van-Zweiten et al. 2004). Consequently, the accumulated and combined effects, also called the cocktail effect, of both endosulfan and copper have negative outcomes on human health and the environment.

Alternative pest managements

Some of the farmers employ integrated pest management (IPM) on Robusta. This implies that the farmers manage their crops in ways that promotes plant health, and reduce the use of pesticides that are harmful for human health and the environment (FAO 2002). The farmers use alcohol traps and spores of a beneficial fungus to fight the damaging berry borer. Red-colored alcohol traps are efficient because the red color, similar to that of the coffee berries, attracts female insects, and then they are trapped in a mixture of alcohol and syrup (Dufour & Frérot

2008). Further, the farmers apply dried spores of the fungus *Beauveria bassiana* to reduce the presence of the berry borer. This is because the fungus attacks the insects, producing a poison that eventually kills it (Posada- Flórez 2008). These examples indicate that with diverse management techniques, the farmers can control outbreaks and manage the Robusta plants in ecologically sustainable ways, and they do not only depend on chemicals and follow the advices from CISA.

Reflections on the theoretical framework

I use the SLA framework as a base to analyze how a commercial crop like Robusta changes the farm activities of rural farmers in Nueva Guinea (Scoones 2009). However, because I focus on changes at a farm-level, I have not focused on how global processes such as global trade and climate change, indirectly and directly affects rural farmers in Nueva Guinea. Global markets and trends play an important role in the coffee production and trade, as Nestlé controls most of the production and London Stock Exchange determines the price of Robusta.

Therefore, to complement this research, there is a need to develop a broader understanding of how multinational companies affect rural livelihoods, for example in Nueva Guinea, and to analyze how price fluctuations on the global market have long-term effects on rural farmers (Bacon 2008; Scoones 2009). A long-term study of the climatic changes in the Caribbean region and how this affects the production systems of the rural farmers provides a complementary view of how the production of Robusta challenges or enhances the resilience of farm systems in Nueva Guinea.

POSSIBLE FUTURES OF ROBUSTA

Comparative studies of Robusta

Experiences from Brazil and Vietnam

Brazil and Vietnam have produced Robusta for decades, and small-scale farmers account for most of the production (Müller & Zeller 2002; Sales et al. 2013). Brazil is the world's largest producer of Robusta, followed by Vietnam (Bunn et al. 2014). In Brazil, Robusta is produced on 4600km^2 in the state of Espirito Santo on the south Atlantic coast. Nearly 80% of the coffee production is done by small-scale farmers, and they produce Robusta in open systems with no plant and tree cover (Sales et al. 2013). In Vietnam, Robusta has been produced extensively since the 1990s, when the government established large Robusta plantations in the central highlands (Marsh 2007; Winkels 2008). This attracted thousands of farmers to invest in the production, and in 2000 the central highlands were covered with 5300km^2 of Robusta plantations (Winkels 2008). In contrast, Mercon targets 79km^2 of Robusta plantations in Nicaragua the coming years, a small fraction of what Brazil and Vietnam produces.

The intense production of Robusta in Brazil and Vietnam has drastically changed the landscapes, as in Nueva Guinea. In Brazil, the production of Robusta has reduced the vegetative cover of the Atlantic forest biome, a biodiversity hotspot in Brazil, and this threatens natural biodiversity (Sales et al. 2013). To improve this, the Brazilian government made a project in 2002 to encourage coffee farmers to invest in agroforestry systems. To increase biodiversity in the region, the agroforestry systems created forest-like farm systems and ecological corridors that benefit numerous organisms. Some farmers joined this development and they benefit from a diverse production system; with various food crops and trees, rather than growing Robusta in a single-crop system (Sales et al. 2013).

In Vietnam, the production of Robusta has replaced the land that was previously used to grow food crops and this threatens their food security (Müller & Zeller 2002; Sales et al. 2013). In Vietnam, fluctuating prices and the high costs of the Robusta production leads farmers into a vicious circle of high debts they struggle to pay back (Tan 2000; Winkels 2008). This pressure farmers to invest in alternative crops, as rubber, pepper and other food crops to cover their dietary needs and the high costs related to the production of Robusta. The farmers in Nueva Guinea are motivated by the high profit of selling Robusta, and this is what encourages them to increase their production. However, if they continue to plant Robusta on land they grow food

crops it would reduce their food availability and pressure them to invest in alternative crops to sustain their incomes.

As in Brazil and Vietnam, farmers in Nueva Guinea are rapidly expanding the production of Robusta. Mercon said that Robusta "*reforests the landscape*", but as seen in Brazil the intense production of Robusta rather deforests the landscape. Nueva Guinea borders to Punta Gorda, a natural reserve that covers large parts of the south Caribbean region **(figure** 4) (Moreno 2004). This reserve is protected by the Nicaraguan government, but the landscape that surrounds Punta Gorda is fragmented and dominated by agricultural fields. This creates an ecological barrier to organisms that depend on diverse ecosystems (Perfecto et al. 2014; Perfecto & Vandermeer 2015). Therefore, if farmers continue to plant Robusta as CISA recommends, it would transform the south Caribbean into a unilateral landscape of Robusta, and consequently it could reduce the habitat for numerous species (Perfecto et al. 2014).

Figure 4: Satellite image of the south Caribbean region, showing Nueva Guinea and the boundaries to Punta Gorda Natural Reserve (Google 2017).

Future trajectories of production of Robusta in Nueva Guinea

The farmers in Nueva Guinea who have invested in the production of Robusta have gone from being subsistence farmers to rely on the income from a commercial crop; but is this a sustainable

option for the rural farmers? All the interviewed farmers wished to expand the production of Robusta if the profit remains high, while Mercon plan to expand the production of Robusta in the Caribbean region to 7900 ha in the coming years (CISA 2016). After I conducted my fieldwork, in November 2016 the Nicaraguan government approved a law that allows the production of Robusta in all the regions of Nicaragua at altitudes lower than 400 meters above sea level, and those situated more than 30 kilometers from Arabica plantations (Alvarez 2016). This means that Robusta could be produced on large areas, except from the main coffee regions in the north. This enables Mercon to invest in Robusta throughout Nicaragua, and more farmers can participate in what a farmer in Nueva Guinea called "*... a positive development because Robusta gives economic opportunities for the rural poor in the Caribbean region*" (José 2016). Another farmer said that "*Robusta is a crop for the poor because it produces well on poor soils and improve the income of the poorest in Nueva Guinea*" (Pedro 2016).

Experiences from northern Nicaragua

Studies on how rural farmers experience the production of coffee Arabica in northern Nicaragua suggest possible future trajectories for expanding the Robusta production in Nueva Guinea. As with the farmers in Nueva Guinea, the high profit from producing coffee motivates northern farmers to invest in Arabica (Bacon 2008). In November 2016, the price of Arabica was nearly double that of Robusta, $4/kg and $2,3/kg respectively (WB 2017). Bacon et al., (2014) showed that northern farmers have to reduce their food intake in critical faces because the income from Arabica is too low (Bacon et al. 2014). Farmers in Nueva Guinea earned nearly half of what the northern farmers earned in November 2016, and as the northern farmers already struggle when prices are low, the future of the farmers in Nueva Guinea looks rather gloomy. Alternative trade networks could however, improve the income of the rural farmers in Nueva Guinea.

Alternative trade networks

Alternative networks emerge as alternatives to global free trade, and enable farmers in Nicaragua to receive price premiums if their products are organic, bird friendly or if they have working conditions that qualify to the organizations' standards (Jaffe & Bacon 2008; LeClair 2002). Alternative trade networks empower and engage farmers because they know who they are producing for, and the consumers know who they are buying from (Utting-chamorro 2005). Bacon (2008) showed that in the north of Nicaragua, certifications as Fair Trade and organic pays up to 65% more than what conventional agro-export companies pays. The high prices of

certified coffee therefore motivates farmers to diversify their farm activities and to produce according to the certification standards (Bacon 2008).

Alternative trade networks in Nueva Guinea could increase the value of the Robusta production in contrast to solely depending on CISA and Nestlé, for production and sale of Robusta. Some of the farmers I interviewed said that alternative trade networks would challenge the monopsony of CISA, create market competition and this would most likely increase the price of Robusta. Nestlé controls 56% of the global instant coffee industry, but instant coffee is rarely certified as organic or fair trade (Bacon et al. 2008b). Organic certifications could motivate farmers to produce without chemical inputs, while Fair Trade certifications could encourage farmers to work after their standards.

Cooperatives and farmers' organizations are important to small-scale coffee farmers in Nicaragua, and they have been important to rural farmers since the Sandinistas seized power in 1979 (Wilson 2013). Studies show that well-organized coffee cooperatives provide services such as credits, access to markets, technical assistance and they assist farmers in emergencies (Bacon et al. 2014; Beuchelt & Zeller 2012; Landmann & Cadilhon 2016). It is expensive and time-consuming to be certified Fair Trade, organic or bird friendly – but if farmers are organized in cooperatives and apply for group certifications, it reduces the costs significantly (Daviron et al. 2005). Therefore, if the coffee farmers in Nueva Guinea are organized in cooperatives and not only depend on CISA, they could access alternative markets and receive price premiums if they produce Robusta according to the certification's standards.

CONCLUSION

The Caribbean region has been poorly developed since the Somoza dictatorship, but political reforms, population growth and agricultural expansions have empowered rural farmers in the region. Mercon's investment in the production of Robusta in Nueva Guinea enables rural farmers to invest in a high-value crop and to diversify their farm activities. The farmers I interviewed emphasized that the high income of Robusta motivates them to expand the production, but as seen in this study the production of Robusta is also costly and the farmers apply large quantities of harmful chemicals; challenging the social and environmental sustainability of the production of Robusta in Nueva Guinea.

The farmers I interviewed said that alternative trade networks would increase market competition, and if there were other buyers of Robusta, it would be better than to depend solely on CISA and Mercon. Alternative trade networks are however, not the single best solution – neither is certifications or to diversify the farm activities (Bacon et al. 2008b). To empower and engage rural farmers in Nueva Guinea, the farmers must influence the production and sale of Robusta. Most of the farmers I interviewed employ alternative management techniques in contrast to how CISA recommends them to manage the production of Robusta. If the farmers in Nueva Guinea could benefit from this alternative management strategy, it would increase the value of the production of Robusta.

The unity between some of the farmers in Nueva Guinea is strong and knowledge sharing is important to most of the interviewed farmers. This lay the basis for a togetherness that will be significant as the production of Robusta continues to expand in the region. Some of the farmers in Nueva Guinea have also diversified beyond the agricultural production, within tourism and food processing, and this could be an option for other farmers not solely depend on the income from Robusta.

Coffee is one of the world's most important commercial crops and the so-called free trade market has done little to improve the living conditions of rural farmers in the tropics. Central topics within agroecology and socioecological resilience are to conserve traditional knowledge and to empower the rural poor. The production of Robusta in Nicaragua is rapidly expanding and there is a need to expand the research on how rural farmers cope with that production; to improve the farmers' abilities to cope with future internal and external changes.

REFERENCES

Abbott, L. K. & Murphy, D. V. (2007). *Soil Biological Fertility: A Key to Sustainable Land Use in Agriculture*. 1 ed.: Springer Netherlands. 264 pp.

Acuna, E., Rodríguez, I. & Wielemaker, W. (1992). Estudio del uso de la tierra, suelos y paisajes de Nueva Guinea, Nicaragua (*Study of landuse, soils and landscape in Nueva Guinea, Nicaragua)*. Costa Rica: Centro Agronomico Tropical de Investigacion y Ensenanza, CATIE.

Adelana, S. M. A. (2005). Nitrate Health Effects. In *Water Encyclopedia*, p. 4128: John Wiley & Sons, Inc.

Altieri, M. (1999). The ecological role of biodiversity in agroecosystems. *Ecosystems and Environment*, 74 (1-3): 19-31.

Alvarez, D. G. (2016). Gobierno da luz verde a café robusta. In *La Prensa*. Available at: http://www.laprensa.com.ni/2016/12/05/economia/2145864-gobierno-da-luz-verde-a-cafe-robusta (accessed: 5.12).

ANA. (2010). Ley General de Aguas Nacionales y Reglamento de la Ley General de Aguas Nacionales (*General Law on National Waters)*. In *The Government of Nicaragua* Available at: http://www.ifrc.org/docs/IDRL/Nicaragua/LEY DE AGUA.pdf (accessed: 10.05).

Arnove, R. (1995). Adult Education and State Policy in Latin America: The Contrasting cases of Mexico and Nicaragua. *Comparative Education*, 31 (3): 311-326.

ATSDR. (2015). Endosulfan - ToxFAQs. In *Agency for Toxic Substances and Disease Registry* Available at: https://www.atsdr.cdc.gov/toxfaqs/tfacts41.pdf (accessed: 24.03).

Bacon, C. (2008). *Confronting the coffee crisis: fair trade, sustainable livelihoods and ecosystems in Mexico and Central America*. London, England: MIT Press. 380 pp.

Bacon, C., Ernesto, M., Gómez, M. E. F., Stuart, D. & Flores, S. R. D. (2008a). Are Sustainable Coffee Certifications Enough to Secure Farmer Livelihoods? The Millenium Development Goals and Nicaragua's Fair Trade Cooperatives. *Globalizations*, 5 (2): 259-274.

Bacon, C., Méndez, E. & Fox, J. (2008b). Cultivating Sustainable Coffee: Persistent Paradoxes. In Bacon, C., Méndez, E., Gliessman, S., Goodman, D. & Fox, J. (eds) *Confronting the Coffee Crisis*. London: The MIT press.

Bacon, C. (2010). A Spot of Coffee in Crisis. *Latin American Perspectives*, 37 (2): 50-71.

Bacon, C., Sundstrom, W., Flores Gómez, M. E., Méndez, E., Santos, R., Goldoftas, B. & Dougherty, I. (2014). Explaining the 'hungry farmer paradox': Smallholders and fair trade cooperatives navigate seasonality and change in Nicaragua's corn and coffee markets. *Global Environmental Change*, 25: 133-149.

Bacon, C. M. (2008). *Confronting the coffee crisis: fair trade, sustainable livelihoods and ecosystems in Mexico and Central America*: MIT Press.

Bebbington, A. (1999). Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty. *World Development* 27 (12): 2012-2044.

Bernard, R. (2006). *Research in Methods in Anthropology*. United States: AltaMira Press. 824 pp.

Beuchelt, T. D. & Zeller, M. (2012). The role of cooperative business models for the success of smallholder coffee certification in Nicaragua: A comparison of conventional, organic and Organic-Fairtrade certified cooperatives. *Renewable Agriculture and Food Systems*, 28 (3): 195-211.

Biderman, J. (1983). The Development of Capitalism in Nicaragua: A Political Economic History *Latin American Perspectives*, 10 (1): 7-30.

Brundtland, G. H. (1987). Our Common Future—Call for Action. *Environmental Conservation*, 14 (4): 291-294.

Bunn, C., Läderach, P., Ovalle Rivera, O. & Kirschke, D. (2014). A bitter cup: climate change profile of global production of Arabica and Robusta coffee. *Climatic Change*, 129 (1-2): 89-101.

CACRC. (1998). Diagnóstico general sobre la tenencia de la tierra en las comunidades indígenas en la Costa Atlántica (*Diagnostic study of land tenure in indigenous communities on the Atlantic coast)*. In *Central American and Caribbean Research Council* Available at: http://www.pueblosindigenaspcn.net/biblioteca/doc_view/138-diagnostico-general-sobre-la-tenencia-de-tierras-costa-atlantica-nicaragua.html (accessed: 10.05).

Castellón, L. B. (2014). Café robusta en expansión (*Coffee Robusta in expansion*). Available at: http://www.laprensa.com.ni/2014/05/15/economia/194453-cafe-robusta-en-expansion.

Castro, A. R. (2007). Estado del agua y saneamiento, RAAS, Nicaragua (*State of water and sanitation, RAAS, Nicaragua*). In *World Bank*. Available at: https://www.wsp.org/sites/wsp.org/files/publications/521200850008_Saneamiento_Nicaragua_final.pdf.

Chambers, R. & Conway, G. (1991). Sustainable rural livelihoods: practical concepts for the 21st century. *International Development Studies*.

CISA. (2016). *Interview with the manager of CISA in Nueva Guinea* Nueva Guinea, Nicaragua (11.2016).

Cleary, D. (2003). People-Centred Approaches. In Baumann, P., Bruno, M., Flores, X. & Warren, P. (eds): Food and Agricultural Organization.

Clifford, M. N. & Willson, K. C. (1985). *Coffee: botany, biochemistry, and production of beans and beverage*. 1 ed.: Springer US.

Cuthbert, D. W. & Alvarez, V. R. (2014). Breve Caracterizacion Conceptual de la Problematica Socioeconomica de la Costa Caribe de Nicaragua (*Brief Conceptual Characterization of Socioeconomic Problems of the Caribbean Coast of Nicaragua*).

DaMatta, F. (2004). Ecophysiological constraints on the production of shaded and unshaded coffee: a review. *Field Crops Research*, 86: 99-114.

DaMatta, F., Ronchi, C., Maestri, M. & Barros, R. (2007). Ecophysiology of coffee growth and production. *Plant Physiology*, 19 (4): 485 - 510.

Daviron, B., Ponte, S., Agricultural, T. C. f. & Cooperation, R. (2005). *The Coffee Paradox: Global Markets, Commodity Trade and the Elusive Promise of Development*: Zed Books.

De Beenhouwer, M., Aerts, R. & Honnay, O. (2013). A global meta-analysis of the biodiversity and ecosystem benefits of coffee and cacao agroforestry. *Agriculture, Ecosystems and Environment*, 175: 1-7.

Dufour, B. P. & Frérot, B. (2008). Optimization of coffee berry borer, Hypothenemus hampei Ferrari (Col., Scolytidae), mass trapping with an attractant mixture *Journal of Applied Entomology*, 132: 561-600.

Eaton, C. & Shepherd, A. W. (2001). Contracting farming: Partnership for growth. In *Food and Agricultural Organization*. Available at: http://www.fao.org/docrep/014/y0937e/y0937e00.pdf (accessed: 10.5).

ECHA. (2014). Background document: Copper sulphate pentahydrate. In *European Chemicals Agency* Available at: https://echa.europa.eu/documents/10162/177dac25-88af-4ee3-82a2-6fd6dede3d52 (accessed: 10.05).

Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries*: Oxford University Press.

EPA. (2002). Endosulfan RED Facts. In *U.S Environmental Protection Agency* Available at: https://archive.epa.gov/pesticides/reregistration/web/html/endosulfan_fs.html (accessed: 24.03).

Estrada, V. R. (2013). El campesinado migrante. Políticas agrarias, colonizaciones internas y movimientos de frontera agrícola en Nicaragua, 1960 – 2012 (*The migrating peasant: Agrarian policies, internal colonization and agricultural frontier movements in Nicaragua, 1960-2012*). *Revista de Estudios Históricos (Journal of Historical Studies)*, 57.

F-ODM. (2008). Revitalización Cultural y Desarrollo Productivo Creativo en la Costa Caribe de Nicaragua (*Cultural Revitalization and Creative Productive Development on the Caribbean Coast of Nicaragua*). In *United Nations*. Available at: http://www.mdgfund.org/sites/default/files/Signed_JP_Nicaragua_Culture_Dec.%2708.pdf.

F-ODM. (2013). Gobernabilidad Económica del Sector Agua Potable y Saneamiento en la Región Autónoma del Atlántico Norte (RAAN) y la Región Autónoma del Atlántico Sur (RAAS), Nicaragua (*Economic governance of the drinking water and sanitation sectors in RAAN and RAAS*). Nicaragua: Fondo Para el Logro de los ODM, United Nations

FAO. (1996). The World Food Summit: Rome Declaration on World Food Security. In *Food and Agriculture Organization*. Available at: http://www.fao.org/docrep/003/w3548e/w3548e00.htm (accessed: 10.05).

FAO. (2002). World agriculture: towards 2015/2030: Summary report In *Food and Agriculture Organization* Available at: http://www.fao.org/3/a-y3557e.pdf (accessed: 10.05).

FAO, Frankenberger, T. & McCaston, M. (2017). *The household livelihood security concept* Food and Agriculture Organization. Available at: http://www.fao.org/3/a-x0051t/X0051t05.pdf (accessed: 10.05).

Francis, C., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Harwood, R., Salomonsson, L., Helenius, J., Rickerl, D., Salvador, R., et al. (2003). Agroecology: The Ecology of Food Systems. *Journal of Sustainable Agriculture*, 22 (3): 99-118.

Franzoni, J. M. (2013). Sistemas de protección social en Nicaragua (*Social protection systems in Nicaragua)*. In *Comisión Económica para América Latina y el Caribe (CEPAL) & United Nations* Available at: http://repositorio.cepal.org/bitstream/handle/11362/4067/1/S2013136_es.pdf (accessed: 10.05).

Fraser, J., Fisher, E. & Arce, A. (2014). Reframing 'Crisis' in Fair Trade Coffee Production: Trajectories of Agrarian Change in Nicaragua. *Journal of Agrarian Change*, 14 (1): 52-73.

Goodland, R. (1995). The Concept of Environmental Sustainability. *Ecology and Systematics*, 26: 1-24.

Google. (2017). *Satellite map of Punta Gorda Natural Reserve*: Google Earth Pro.

Hall, R., Scoones, I. & Tsikata, D. (2017). Plantations, outgrowers and commercial farming in Africa: agricultural commercialisation and implications for agrarian change. *The Journal of Peasant Studies*, 44 (3): 515-537.

Hilten, J. v. H. (2012). Coffe quality: Robusta. In *The Coffee Guide*, pp. 203-209. Geneva: International Trade Centre (ITC).

Holt-Giménez, E. & Altieri, M. A. (2013). Agroecology, Food Sovereignty, and the New Green Revolution. *Agroecology and Sustainable Food Systems*, 37 (1): 90-102.

Hord, N. G. & Conley, M. N. (2017). Regulation of Dietary Nitrate and Nitrite: Balancing Essential Physiological Roles with Potential Health Risks. In Bryan, N. S. & Loscalzo, J. (eds) *Nitrite and Nitrate in Human Health and Disease*, pp. 153-162. Cham: Springer International Publishing.

Horton, L. (2013). From Collectivism to Capitalism: Neoliberalism and Rural Mobilization in Nicaragua. *Latin American Politics and Society*, 55 (1): 119-140.

ICO. (2017). ICO Indicator Prices - February 2017. Available at: http://www.ico.org/prices/p1-February2017.pdf (accessed: 10.05).

INIDE. (2005). Censo de Población y de Vivienda, 2005 (*Population and housing census, 2005*). In *Instituto Nacional de Información de Desarollo*. Available at: http://www.inide.gob.ni/censos2005/VolPoblacion/Volumen Poblacion 1-4/Vol.IV Poblacion-Municipios.pdf (accessed: 10.05).

IPCC. (2014). Climate Change 2014: Synthesis Report. In *Intergovernmental Panel on Climate Change*. Available at: https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf (accessed: 10.05).

Jaffe, R. & Bacon, C. (2008). From Differentiated Coffee Markets toward Alternative Trade and Knowledge Networks. In Bacon, C. (ed.) *Confronting the Coffee Crisis*, pp. 311-336. London: MIT press.

Jaffee, D. (2007). *Brewing Justice: Fair Trade Coffee, Sustainability and Survival*. 1 ed.: University of California Press. 401 pp.

José. (2016). *Interview with a farmer in Nueva Guinea*. Bjørge, H. (ed.).

Klein, A.-M., Dewenter, I. S. & Tscharntke, T. (2003). Bee Pollination and Fruit Set of Coffea Arabica and C. Canephora (Rubiaceae). *American Journal of Botany*, 90 (1): 153-157.

Landmann, D. & Cadilhon, J.-J. (2016). With trust and a little help from our friends: How the Nicaragua learning alliance scaled-up training in agribusiness. In Dror, I., Cadilhon,

J.-J., Schut, M., Misiko, M. & Maheshwari, S. (eds) *Innovation platforms for agricultural development: Evaluating the mature innovation platforms landscape*. United Kingdom: Routledge.

LeClair, M. (2002). Fighting the Tide: Alternative Trade Organizations in the Era of Global Free Trade. *World Development*, 30 (6): 949-958.

Lin, B., Perfecto, I. & Vandermeer, J. (2008). Synergies between Agricultural Intensification and Climate Change Could Create Surprising Vulnerabilities for Crops. *BioScience*, 58 (9): 847-854.

Magfor. (2008). Nueva Guinea en cifras (*Nueva Guinea in numbers*). In *Ministry of Agriculture* Available at: http://www.inide.gob.ni/censos2005/CifrasMun/RAAS/Nueva Guinea.pdf (accessed: 10.05).

Magfor. (2009). Fortalecimiento al Sistema Nacional de Semilla (*Strengthening the National Seed System*). Managua, Nicaragua: Ministry of Agriculture and Forestry.

Magfor. (n.d). *Nueva Guinea*. Available at: http://www.bvsde.org.ni/Web_textos/INIFOM/CDdeCaracterizaciones/Caracterizaciones/Raas/lenin/NuevaGuinea.htm (accessed: 8.02).

Marsh, A. (2007). Diversification by smallholder farmers: Vietnam, Robusta Coffee. In *Food and Agricultural Organization* Available at: http://www.fao.org/docrep/016/ap301e/ap301e.pdf (accessed: 10.05).

McMichael, P. (2015). A comment on Henry Bernstein's way with peasants, and food sovereignty. *The Journal of Peasant Studies*, 42 (1): 193-204.

Méndez, V. E., Lok, R. & Somarriba, E. (2001). Interdisciplinary analysis of homegardens in Nicaragua: micro- zonation, plant use and socioeconomic importance. *Agroforestry Systems*, 51 (2): 85-96.

Mercon. (2016). *Robusta in Nicaragua* Available at: http://www.merconcoffeegroup.com/about-us/what-do-we-do/other-businesses/robusta-plantations/ (accessed: 10.05).

MIFIC. (2008). Ficha Producto "Café" en Nicaragua (*Product information "Coffee" in Nicaragua*). In *Ministry of Development, Industry and Trade*. Available at: http://cenida.una.edu.ni/relectronicos/RENE71N583c.pdf (accessed: 10.05).

Miguel, J. (2016). *Mapa Base - Avance Fisio, Nueva Guinea* Map of the communities in Nueva Guinea, Nicaragua.

Morelli, J. (2011). Environmental Sustainability: A Definition for Environmental Professionals. *Journal of Environmental Sustainability*, 1 (1).

Moreno, G. B. (2004). Programa de Pago por Servicios Ambientales para el desarollo y la conservación de la Reserva de Biosfera del Sureste de Nicaragua (Program for environmental services payments for the development and conservation of the Southeast Biosphere Reserve in Nicaragua). In *Fundación Instituto de Politicas para la Sostenibilidad (IPS)*. Available at: http://www.aecid.org.ni/wp-content/uploads/2014/02/1269880824_Informe-final-PSA-San-Carlos.pdf (accessed: 10.05).

Müller, D. & Zeller, M. (2002). Land use dynamics in the central highlands of Vietnam: a spatial model combining village survey data with satelite imagery interpretation *Agricultural Economics*, 27 (3): 333-354.

Nunan, F. (2015). *Understanding Poverty and the Environment: Analytical Frameworks and Approaches*: Routledge. 220 pp.

Ovalle-Rivera, O., Laderach, P., Bunn, C., Obersteiner, M. & Schroth, G. (2015). Projected shifts in Coffea arabica suitability among major global producing regions due to climate change. *PLoS One*, 10 (4): e0124155.

Pedro. (2016). *Interview with farmer in Nueva Guinea*. Bjørge, H. (ed.).

Perfecto, I., Vandermeer, J. & Philpott, S. (2014). Complex Ecological Interactions in the Coffee Agroecosystem. *Annual Review of Ecology, Evolution, and Systematics*, 45 (1): 137-158.

Perfecto, I. & Vandermeer, J. (2015). *Coffee Agroecology: A New Approach to Understanding Agricultural Biodiversity, Ecosystem Services and Sustainable Development*: Taylor & Francis.

Petchers, S. & Harris, S. (2008). The Roots of the Coffee Crisis. In Bacon, C., Méndez, E., Gliessman, D. & Fox, J. (eds) *Confronting the Coffee Crisis*, pp. 43-66. London: The MIT Press.

PNDH. (2012). Plan Nacional de Desarrollo Humano 2012-2016 (*National Plan on Human Development 2012-2016*). In *Plan Nacional de Desarrollo Humano*. Available at: http://www.pndh.gob.ni/ (accessed: 10.05).

Posada- Flórez, F. (2008). Production of Beauveria bassiana fungal spores on rice to control the coffee berry borer, Hypothenemus hampei, in Colombia. *Journal of Insect Sciences*, 8 (41): 13.

Sales, E. F., Méndez, E., Caporal, F. R. & Faria, J. C. (2013). Agroecological Transition of Conilon Coffee (Coffea canephora) Agroforestry Systems in the State of Espírito Santo, Brazil. *Agroecology and Sustainable Food Systems*, 37 (4): 405-429.

Samberg, L., Gerber, J., Ramankutty, N., Herrero, M. & West, P. (2016). Subnational distribution of average farm size and smallholder contributions to global food production. *Environmental Research Letters*, 11 (12): 124010.

Savci, S. (2012). Investigation of Effect of Chemical Fertilizers on Environment *Science Direct*, 1: 287-292.

Schaller, M., Schroth, G., Beer, J. & Jiménez, F. (2003). Species and site characteristics that permit the association of fast-growing trees with crops: the case of Eucalyptus deglupta as coffee shade in Costa Rica *Forest Ecology and Management* 175 (1-3): 205-215.

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, 36 (1): 171-196.

Sollis, P. (1989). The Atlantic Coast of Nicaragua: Development and Autonomy. *Journal of Latin American Studies*, 21 (3): 481-520.

Somarriba, E. (1992). Revisiting the past: an essay on agroforestry definition. *Agroforestry Systems*, 19 (3): 233-240.

Spoor, M. (1994). Issues of State and Market: From Interventionanism to Deregulation of Food Markets in Nicaragua. *World Development*, 22 (4): 517-533.

Suárez, A. V. & Solis, J. (2013). Revitalización cultural y desarrollo productivo creativo en la Costa Caribe nicaragüense (*Cultural revitalization and creative productive development on the Nicaraguan Caribbean Coast*). In UN. Available at: http://www.mdgfund.org/sites/default/files/Signed_JP_Nicaragua_Culture_Dec.%2708.pdf (accessed: 10.05).

Sunderland, T. C. H. (2011). Food security: why is biodiversity important? *International Forestry Review*, 13 (3): 265-274.

Tan, S. B.-H. (2000). Coffee frontiers in the Central Highlands of Vietnam: networks of connectivity. *Asia Pacific Viewpoint*, 41 (1): 51-67.

Torres, M. O. (2008). Diagnóstico de género en la economía rural de Nicaragua (*Gender analysis in the rural economy of Nicaragua*): World Bank.

Tscharntke, T., Clough, Y., Wanger, T., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*, 151 (1): 53-59.

UN. (2005). Guidance Note on Recovery: Livehood. In *United Nations* Available at: http://www.undp.org/content/dam/india/docs/guidance_note_on_recovery_livelihood.pdf (accessed: 10.05).

UNEP. (2011). Stockholm Convention on Persistent Organic Pollutants In *United Nations Environmental Program*. Available at: https://www.thegef.org/sites/default/files/documents/UNEP-POPS-COP.4-38.English.pdf (accessed: 10.05).

UNICEF. (2012). Ninez y Adolescencia Nicaragüense (*Nicaraguan children and adolescents*). In *UNICEF*. Available at: https://www.oas.org/dil/esp/Codigo_de_la_Ninez_y_la_Adolescencia_Nicaragua.pdf (accessed: 10.05).

UNICEF. (2015). Country Scenario: Nicaragua. In *United Nations* Available at: http://en.unicef.org.ni/panorama-pais/

USDA. (2016). Precio de granos basicos, Nicaragua (*Prices of basic grains, Nicaragua*). Nicaragua: United States Department of Agriculture.

Utting-chamorro, K. (2005). Does fair trade make a difference? The case of small coffee producers in Nicaragua. *Development in Practice*, 15 (3-4): 584-599.

Van-Zweiten, L., Merrington, G. & Van-Zweiten, M. (2004). *Review of impacts on soil biota caused by copper residues from fungicide application*. SuperSoil 2004, University of Sidney: Austrailian New Zealand Soils Conference.

Walliman, N. (2006). *Social Research Methods*: SAGE Publications.

WB. (2017). *Prices of coffee arabica and robusta*: World Bank. Available at: https://ycharts.com/indicators/world_coffee_arabica_price https://ycharts.com/indicators/world_coffee_robusta_price (accessed: 26.04).

Wilson, B. (2013). Breaking the Chains: Coffee, Crisis, and Farmworker Struggle in Nicaragua. *Environment and Planning A*, 45 (11): 2592-2609.

Wilson, B. R. (2009). Indebted to Fair Trade? Coffee and crisis in Nicaragua. *Geoforum*, 41 (1): 84-92.

Winkels, A. (2008). Rural In-migration and Global Trade. *Mountain Research and Development*, 28 (1): 32-40.

APPENDICES

Appendix 1: Elaboration of the sustainable livelihood approach (SLA)

The sustainable livelihood approach (SLA) was developed to understand how rural livelihoods depend on diverse strategies to survive. It was developed in the 1980s by development researcher Robert Chambers and agricultural ecologist Gordon Conway (Nunan 2015). The SLA framework was a response to the 1987 Brundtland report on sustainable development. The report was called "Our Common Future" and it presented a framework on how to stimulate social and economic progress on the world's resources, without reducing the resources for future generations (Brundtland 1987). Therefore, SLA was developed to get a more holistic perspective on sustainable development.

Because "Our Common Future" made economic growth a strategy and a goal for sustainable development, Conway and Chambers argued that it was insufficient to cover rural and agrarian livelihoods (Chambers & Conway 1991). According to Ian Scoones (2009), a livelihood can range from an individual, a household, a family or a village (Scoones 2009).

To capture the complexity and diversity of these livelihoods, they made a framework to analyze the resources people depend on for a living. Conway and Chambers named resource uses "capitals". They divided the capitals into five categories: social, natural, financial, human and physical (Chambers & Conway 1991; Scoones 2009). These capitals are both means of making a living, but can also create capabilities for wellbeing (Bebbington 1999).

Appendix 2: Ethical declaration from the interviews

DECLARACION DE CONSENTIMIENTO

Mi nombre es Hedvig Bjørge con nacionalidad Noruega. Estoy colaborando con el Grupo MERCON, con el apoyo del Centro Internacional de Agricultura Tropical, que trabaja en agricultura, para llevar a cabo un estudio sobre la produccion de café Robusta en Nueva Guinea, ademas de los sitemas de produccion agricola en varios comunidades de la municipalidad. La informacion proveída será utilizada para tener más conocimiento sobre el desarrollo de la produccion de café Robusta en este region. Su participacion es voluntaria y sus respuestas se mantendrán confidenciales. La entevista demorará aproximadamente una hora.

¿Tiene alguna pregunta sobre esta entrevista? ***<Encuestador: pause y responda a cualquier pregunta que tenga la persona entrevistada; luego continúe con la siguiente declaración:>***

Si Usted no tiene preguntas o si he contestado a sus preguntas de forma satisfactoria, me gustaría empezar la entrevista. Al responder a mis preguntas, usted indica que acepta participar voluntariamente en la encuesta.

Appendix 3: Sample interviews

3a: Example of a questionnaire from the interviews in Nueva Guinea (I have changed the original name of the interviewee and the farm name).

Fecha: 22/10-16 **Comunidad:** Los Pintos **Nombre del productor:** Miguel **Nombre de la finca:** Bella Vista

Ahora quisiera hablar sobre los **cultivos anuales** que **siembra actualmente** (adicional a café) y los que sembraba **antes** de haber sembrado **café robusta**. Para cada uno de ellos apreciaré que responda las siguientes preguntas:

CX	CY	C2a	C3c	C4	C5a	C5b	C6	C7a	C7b	C8a	C8b
Cultivos anuales	**Cuándo sembró?**	**Área sembrada**	**Sólo para café: Cantidad producida es en…** 1=Fruto/uva 2=Pergamino húmedo 3=Pergamino seco 4=Oro 99=Otro (especificar)	**Destino principal de esta cosecha?** 1=Venta 2=Autoconsumo 3=Venta y auto-consumo 99=Otro (especificar)	Cuál de estos era el primer, segundo y tercer **cultivo más importante para la producción de alimentos para consumo** en su hogar?	Cuál de estos era el primer, segundo y tercer **cultivo más importante como fuente de ingresos agrícolas** para su hogar?	Qué tipo de **mano de obra emplea/ empleaba** durante el ciclo de producción? 1=Familiar 2=Contratada 3=Familiar y Contratada	Aplica/ aplicaba usted **fertilizantes químicos** a este cultivo? 1=Sí 2=No	Aplica/ aplicaba usted **fertilizantes orgánicos** a este cultivo? 1=Sí 2=No	Aplica/ aplicaba usted **pesticidas químicos** a este cultivo? 1=Sí 2=No	Aplica/ aplicaba usted **pesticidas orgánicos** a este cultivo? 1=Sí 2=No
1. Café robusta	**Actualmente**	60MZ	Uva, oro seco	1	Frijol Maíz Plátano	Robusta Piña Plátano	Contratada y familiar	Si	Si	Si	No
2. Cacao	**Actualmente**	8MZ		1							
								Si	Si	Si	No
3. Piña	**Actualmente**	3MZ		3							
								Si	No	Si	No
4. Plátano	**Actualmente**	8MZ		3							
								Si	No	Si	No
5. Maíz	**Actualmente**	6MZ		3							
								Si	No	Si	No
6. Frijol	**Actualmente**	3MZ		3							
								Si	No	Si	No
7. Yuca	**Actualmente**	10MZ		1							
								Si	No	Si	No
8. Ganado	**Actualmente**	150MZ		1/3							

3b: Examples of the semi-structured interview, from the same interviewee as above.

Fecha: _____ **Comunidad:** _____ **Nombre del productor:** _____ **Nombre de la finca:** _____

Ahora vamos a hablar sobre la composición de su hogar, árboles perennes sembrados, fuentes de información, manejo de problemas de cultivo, efectos del cambio climático entre otras cosas…

	Sistema actual	**Sistema antes de Robusta**
Composición familiar Cuántas mujeres hay…? 4 • Mayores de 15 años 4 • Menores de 15 años Cuántos hombres hay…? 1 • Mayores de 15 años? • Menores de 15 años? Cuáles son sus funciones en la finca? Trabajan fuera de la finca *(sí/no)*? • Si sí, qué tipo de actividades hacen fuera de la finca?	(5) admnutra. señor – manejo de trabaj. contro clase – señora hjas estudian	
Cultivos Dónde venden mayormente sus cultivos anuales? *(finca, casa, comunidad, mercado en otra comunidad, etc.)* Para café: • Venden todo su café a Mercón? *(sí/no)* Si • Si no, qué porcentaje venden a Mercón? • De qué forma venden el café a su principal comprador? *(uva, pergamino húmedo, pergamino seco, oro)* oro – todo		
Animales Qué tipos de animales tiene su hogar? *(búfalos, vacas, caballos, cerdos, cabras, gallinas, etc.)* De estos animales, cuáles son usados principalmente para… • Uso familiar (o en la finca)? • Venta de los animales en el mercado?	lechero – desarrollo hembra creciendo) venta carne – engorde	

semilla - estaqué 6m2 10m2 10 - 10 - 15m - 20m2
- inherto 2 esto - 2012 - 2013 2014 2015 - 2016
lo sembró de este manera para hacer podas en unas partes todo los años - para seguir ganando plata

Fecha: _____ **Comunidad:** _____ **Nombre del productor:** _____ **Nombre de la finca:** _____

	Sistema actual	Sistema antes de Robusta
Con respecto a la siembra de café Robusta Cuándo conocieron/aprendieron sobre el café Robusta? De dónde conocieron/aprendieron sobre el café Robusta? Cuáles fue las motivaciones principales para producir café Robusta? Dónde compran las plántulas/semillas de café Robusta? Han renovado las plantaciones de café Robusta? • Cuándo? no • Cuántas manzanas han renovado? en 2017 • Piensan renovar en el los próximos 2 – 3 anos? podas: 6 m2 2017 Usted tiene un plan de manejo? Qué tipo de información o apoyo técnico reciben de las siguientes fuentes para la producción de café Robusta? • De parte de Mercón? • De productores cercanos? • De otros compradores de café? • Del gobierno/gremio de cafetaleros? nada Qué tipo de facilidades (insumos, préstamos, garantía de compra, etc.) recibe de... • Mercón? • Otros compradores de café?	2008 - Nueva G con CISA en la empresa escuché de otros productores internet gusta la agricultura - un producto de una economía estable - internacional genera mejor rubro económ. precio nivel inter. bolsa inter. mercado ya establecido → pagen en dolares - importante USA - tiene vivero de plant - ~~inhertos~~ / semillas clone / starte manejo de suelo, manejo de plantas desarrollo de grano - del frutos / cosecha tienen reuniones - intercambien ideas	
Cobertura de bosques/árboles (General de la finca) Hay especies de árboles maderables en su finca? *(si/no)* • Cuáles especies son para uso familiar (o en la finca)? • Para venta en el mercado (fuente de ingreso)? Hay especies de árboles frutales en su finca? *(si/no)* • Cuáles especies son para familiar (o en la finca)? • Para venta en el mercado (fuente de ingreso)?	Bosques: 25m2 - siembró 9m2 - teca - comerciales palo de agua, acacia, almendro, mancutón, cedro, caoba - para bosque naranja, mamoren, limón, consumo	

Fecha: _____ **Comunidad:** _____ **Nombre del productor:** _____ **Nombre de la finca:** _____

	Sistema actual	Sistema antes de Robusta
Que beneficios percibe usted de los árboles que tiene en su finca?	no tiene sentidos - dispersos	
Acceso a información (General de la finca) Cuando un cultivo tiene problemas (insectos, enfermedades, etc.) durante el ciclo de producción... • A dónde van a buscar información para resolver este problema? • A dónde van a buscar asistencia técnica? • Cómo resuelven este problema normalmente? *(aplicación de químicos, control cultural, control biológico, etc.)*	Ya tiene información - es buena agropecuaria	
Mano de obra contratada (Café Robusta) Qué actividades durante el ciclo de producción demandan mayor mano de obra? *(siembra, deshierba, aplicación de insumos, cosecha, post-cosecha, etc.)* Qué tipo de mano de obra es más importante durante la siembra? • Contratada? • Vecinos? • Familiar? Qué tipo de mano de obra es más importante a cosecha y post-cosecha? • Contratada? • Vecinos? • Familiar?	10 fijos cosecha 120 personas - noviembre - marzo	
Manejo de insectos/enfermedades (Café Robusta) Qué tipo de manejo emplea para controlar estos problemas? *(aplicación de químicos, control cultural, control biológico, orgánicos, etc.)*		

de Robusta Cooperativa, con metos
100m2 al fin

Jantal

Fecha: _____ **Comunidad:** _____ **Nombre del productor:** _____ **Nombre de la finca:** _____

	Sistema actual	Sistema antes de Robusta
Cómo ha cambiado la productividad de café Robusta en los últimos 5 años? Cómo espera usted que la productividad del suelo para café Robusta cambie en los próximos 5 años?	Igual del año pasado - va bajar la producción por ses en su 2012 - va bajar la producción por ses en su ultimo año	- va renovar / rechapar en 2017
Cambios climáticos (general) En qué mes y qué semana dentro de ese mes **comenzaron** las primeras lluvias en la **PRIMERA** del 2016? En qué mes y qué semana dentro de ese mes **terminaron** las primeras lluvias en la **PRIMERA** del 2016? En qué mes y qué semana dentro de ese mes **comenzaron** las primeras lluvias en la **POSTRERA** del 2016? En qué mes y qué semana dentro de ese mes **terminaron** las primeras lluvias en la **POSTRERA** del 2016? Hace 5 años – las lluvias de **PRIMERA** comenzaban antes o después de las lluvias este año? Hace 5 años – las lluvias de **POSTRERA** comenzaban antes o después de las lluvias este año?	no ha cambiado - más caliente - distr. de agua → no mucho cambio	Antes (30 años) invierno 9 meses verano: 3 meses ahora invierno 6 meses
Preguntas finales: Pensando a Robusta; su manejo, ganancia y valor para su producción- Usted piense que es un cultivo que con mucho potencial para el región? Si no fuera Robusta, que podría haber sido como producción?	Claro, la parte económica de los suelos de muchos años resistente a enferm con buen manejo alta prod. 30-40 q → 1m2 Robust; 100 q/m2 87 este año agua - manejo Hay positivo 10m2 cada año - hasta 2022 por quintal de oro	ha dejado de ganar - porque no sabia negociar el precio del año pasado combinar; productiv. y buen

piña - cacao, platano
- ganadería - leche/carne
Propio plan
→ con la empresa de los gastos/ cuanto vale 55-50 $

Fecha: _____ **Comunidad:** _____ **Nombre del productor:** _____ **Nombre de la finca:** _____

	Sistema actual	Sistema antes de Robusta
• Si realiza manejo químico, dónde compra los productos? • Si realiza manejo orgánico, dónde compra los productos? • Si realiza manejo tradicional/control cultural, cómo es el manejo? La cantidad de insectos y enfermedades que dañan sus cultivos, cómo ha cambiado con respecto a los últimos 5 años? Y la cantidad de insectos benéficos, cómo ha cambiado con respecto a los últimos 5 años? Cómo ve el manejo de insectos y enfermedades en los próximos 5 años?	trampas - limpieza (del árbol/suelo) broca químicos no mucha broca - no roya - hormigas - insecticida - Funciones tragnosa (thong) - químicos no ha cambiado - antes no había broca el café no ha afectado el ecosistema tranquilo - no hay hay área observ químicos - en NG - de USA ganadería - Compostaje no de plantación frijol / maiz / yuca cambio 2a 1,5 años con yuca (Haiñe) maiz, Ahora hay maiz en Robusta - este año no hay en los otros	Funciones
Manejo de suelos (café Robusta) Aplica fertilizante en los lotes donde siembra este café? *(sí/no)* • Qué tipos de fertilizantes aplica? - *Comprado o lo hacen ustedes?* • Dónde consigue dichos fertilizantes? *(mercado/Mercón)* Realiza alguno de los siguientes tipos de manejo alternativos? *(sí/no)* • Manejo tradicional? • Hacen compostaje? si • Hacen rotación de cultivos? • Siembran cultivos de cobertura/para incorporar al suelo? • Intercambian suelos/compostaje entre los vecinos? El suelo ha cambiado (en su estructura o calidad) desde la siembra de Robusta? *(sí/no)* Forma y estructura – y porqué? (*uso de fertilizantes/químicos/ cambio de suelo)*		

mejorado
- aprender a mejorar
abono - Ph
no hay erosion - con la sombra protege

antes pastos en Robusta → compactado un poco - mejor humedad.

Appendix 4: Interviewee details

Extract of the data analysis of the major findings: Each farm is categorized (small, medium, and large) based on the total productive area (in hectares), how Robusta (R) affects soil quality, what the plots where used for before they planted Robusta, and how many they employ in harvest.

Farm	Total (ha)	Robusta (ha)	Category	Cows	R impact soil quality	Before R	Employment harvest
1	7	6,7	S	NO	shade & organic matter	nothing	12
2	14	9,1	M	YES	better, organic matter	paddocks	24
3	14	9,1	M	YES	no change	bought land	5
4	35,2	5	L	YES	drought in 2015 challenged R	paddocks	8
5	28,1	8,4	M	NO	better, organic matter	nothing	20
6	59,1	8,4	L	YES	better, maize produce more with R	food crops	45
7	21,1	2,8	M	YES	no change, porous	food crops	family
8	35,2	7,5	L	YES	improved because of more chemicals	paddocks	family
9	42,2	9,1	L	YES	no changes, lots of weeds	food crops	35
10	3,5	3,5	S	NO	better, more organic and fertile	food crops	15
11	7	2,4	S	NO	porous, fertile, more organic matter	food crops	12
12	28,1	16	M	NO	porous, better results on R	food crops	30
13	211	42,2	L	YES	no erosion, more humidity, better pH	paddocks	120
14	17,6	5,2	M	NO	no change	food crops	12
15	35,2	2,8	L	YES	more chemicals and organic matter	food crops	10
16	7	3,8	S	YES	more organic matter, protected from sun with R	food crops	15
17	188,7	42,2	L	YES	recovers better, more shade with R	paddocks	100
18	88	5,6	L	YES	more porous, better pH	paddocks	4
19	26	4,2	M	YES	more organic matter and produce better	food crops	20
20	17,6	3,5	M	YES	better structure and more fertile	paddocks	16
21	8,8	3,5	S	NO	better structure and more fertile	food crops	family
22	49,3	21,1	L	YES	more organic matter, produce better with R	food crops	150
23	17,6	7	S	YES	no changes (arabica before)	arabica	16
24	140,8	21,1	L	YES	completely changed, more porous and humid	paddocks	50
25	23,2	2,1	M	NO	porous, better results on R	paddocks/food crops	20
26	3,5	2,1	S	YES	permanent R is better for soil	paddocks/food crops	10
27	14	2,8	M	YES	more humid because of treatments	food crops	13
28	70	7	L	YES	more organic matter and produce better	food crops	20
29	84,5	8,4	L	YES	more humid because of treatments	paddocks/food crops	2
30	35,2	3,5	L	YES	no change	paddocks	4
31	17,6	7	M	NO	more humid and recovered	paddocks	family
32	13,3	2,8	M	YES	less erosion and more organic matter	paddocks	30
33	10,5	4,2	M	NO	more humid and softer	food crops	15
34	7	5,6	S	NO	porous, fertile, more organic matter	food crops	no
35	46,4	5,6	L	NO	more humid and recovered	paddocks	no
36	7	3,5	S	NO	porous, fertile, more organic matter	food crops	10

Norges miljø- og biovitenskapelig universitet
Noregs miljø- og biovitskapelege universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway