A MULTI-SITE CASE STUDY OF SIX SMALLHOLDER COFFEE FARMING ASSOCIATIONS IN GUATEMALA: FACTORS THAT INFLUENCE INTENT TO ADOPT NEWLY INTRODUCED COFFEE HYBRIDS

A Dissertation

by

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ABSTRACT

Coffee, especially the Arabica species (*Coffea arabica*), represents a crucial source of income for millions of producers globally, and is especially important to resource-poor populations in Central America. The coffee leaf rust fungus has negatively impacted production both historically and recently, dramatically reducing profitability and in some cases wiping out entire industries. Projections of climate change show increasingly ideal conditions for coffee rust in coming years. These effects have severe impact on smallholders, an important faction of the global coffee industry. Sustainable intensification using improved varieties is the most recommended method to support smallholders facing these challenges. However, it has been well documented that resource-poor farmers are often hesitant to adopt new technologies and struggle to make beneficial long-range decisions. Decision-making becomes more challenging in perennial systems and further exacerbated under pressure from climate change. Factors affecting intent to adopt newly introduced coffee hybrids were identified through focus groups, held with the six smallholder coffee farming associations involved in the Sustainable Incomes through Coffee Farming Improvement project in San Pedro Yepocapa, Guatemala. Methods were designed following the Participatory Rural Appraisal approach, to maximize participation and capacity building of subjects. A total of 12 focus groups were held, collecting data from 107 participants across the six associations. Twelve themes were identified, eight representing obstacles to production and sale of coffee and four related to characteristics of the project. Identified obstacles to

production and sale of coffee included: low and variable coffee prices, limited market access, high costs of coffee transport and field management, debt and lack of land title, access to processing and drying facilities, lack of education and planning, natural factors, and theft of coffee. Identified project characteristics were: past development in the region, confusion between the terms “hybrid” and “GMO”, plantlet health, and processing facility. By examining these themes through the lens of Rogers’ model of innovation decision-making, we aimed to move the needle towards closing the gap in knowledge about what factors, if any, have substantial impact on perception-forming processes of smallholder coffee farmers towards coffee hybrids introduced via development intervention.

DEDICATION

To my mom, who has supported me immensely throughout this endeavor. She encourages me to follow my skills and interests, which have been clear since I was a small child, and facilitated that with everything in her power, without pressure or expectation, with as much love and understanding as she could muster in each moment.

And, to the farmers of Yepocapa and elsewhere, who have persisted in their goals regardless of the obstacles. Coffee farmers live in areas of the world where conflict is high, climate change is real, corruption reigns, and malnutrition is visible. They largely have little formal education, live in poverty, and take on several jobs to feed and clothe their families. Coffee is an economically volatile perennial crop which must be managed year-round and has its value set in faraway places where people pay as much for a latte as production laborers make for a full day's work. Mostly picked by hand, heavy to carry, losing much of its weight in processing and drying, and needing to be processed to have much value. It takes 3-4 years to see a full harvest when new plants are established and is susceptible to a plethora of pests and diseases, which farmers often do not have resources to treat. These are daily realities of coffee farmers, of which they are well aware, and yet they persevere to produce the bulk of the world's coffee without accolades or even adequate compensation. Their stubborn resilience results in the coffee the world enjoys. The farmers of Yepocapa are some of the hardest working, dedicated, thoughtful, articulate and intelligent people I know, and I am incredibly fortunate to have had this time with them. This is their story.

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There are dozens and likely hundreds of people to thank for their support of myself and this work. Most importantly, none of this would have been possible without the assistance of Daniel Dubón, Juan Charuc, Mario Turcios and Wilson Ordoñez, who worked long days to become trained in human subject research, schedule, plan and recruit farmers for the focus groups, make observations throughout the exercises, and sit for hours at the end of already exhaustive days to help me understand every little nuance discussed in the focus groups. Daniel's contribution was especially substantial, and I've thought of him as my Guatemalan counterpart since the initial stages of this project.

A huge thank you to the coffee farming cooperatives, ECA Montellano, Asociación Maya Kiché, Cooperativa San Pedrana, Asociación Chuachilil, COFEAG, and ECA Chuachilil, who allowed us the use of their space and helped facilitate meetings with their associates and Boards of Directors. I am grateful to all the Yepocapa coffee farmers for the time, energy, enthusiasm and candor they shared throughout the many hours of discussion and farm visits.

I would also like to express gratitude to Dr. Christophe Montagnon and Dr. Francisco Anzueto of World Coffee Research, and Dr. Leonardo Lombardini of the Center for Coffee Research and Education at Texas A&M University for their guidance throughout the design and implementation of this study. Thank you also to Beatriz Moreno, and later Marta Ramirez, of Anacafé, for reviewing the research plan to assure the protocol and questions were culturally appropriate, arranging meetings with Anacafé

and Funcafé officials, and writing letters to support funding and IRB applications. And, thank you to Dr. David Laughlin, who made my very first introductions in Yepocapa.

On a more personal note, thank you to my two original lab mates, Keith Read and Lauren Fedenia, who were by my side through the process of developing these ideas, and who have remained important friends even as life has turned our academic paths in different directions. And to Adam Cobb, agronomy scientist and compatriot Fellow of both the Association for International Agriculture and Rural Development Future Leader Forum and the Borlaug Institute for Global Food Security, who helped me re-start my application for funding to live in Guate after an unfortunate incident ended in me losing my computer and said application just days prior to the due date.

I am proud to be honorary members of three Guatemalan families, with Elisa in Petén and Elsa in Antigua the industrious matriarchs of their lovely households, and Juan Sr. and Juan Jr. Charuc, true forces of industry and reason for the Yepocapa region. I cannot thank these families enough for the hospitality, laughs, and humanity shared.

My good friends Nelo Mijangos, Cóndor, and Walter Orellana have also supported me personally and professionally, and helped me understand nuances of Latin American cultures and language. And, as I came into the world of coffee from the production side of things, I am deeply grateful to Alex Brooks of Lalcafé, Josué Morales of Mayaland, Jamie Isetts of Merit, Jacob Ibarra of Tenfold, and Ángelo Batlle of Rio Zarco for fielding my many questions about coffee economics, logistics, purchasing, and cupping, and never making me feel silly for asking even the most basic things.

Finally, I would be amiss not to mention a few uniquely driven individuals who I have come to think of as my core team moving forward. The real purpose of the present study was to understand, from the perspective of the farmers themselves and not in a prescribed way, what exactly is needed to support them. With this information and collaboration from the Yepocapa farmers I intend to develop projects to address the central issues. I believe we can do a great service to coffee production in Yepocapa, while also adding to the body of knowledge regarding obstacles faced by smallholder (coffee) farmers and mechanisms to truly and holistically address them. It's an ambitious goal and I would not be nearly as far along without the efforts and input of Devon Barker, photographer, documentarian and digital guru; Andrew Margenot, soil whisperer (literally); and Erik Stanek, coffee roaster and perennial agronomist with an eye to detail and strategy and words of encouragement reminiscent of a football coach.

To everyone I've missed in this account, and I'm sure there are many, I thank you for your support of myself, this work, marginalized peoples, and smallholder farmers. Any and all mistakes or omittances in the present study are, of course, my own.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Professors Dr. Leonardo Lombardini [chair] and Dr. Charles Hall [co-chair] of the Horticultural Sciences Department; Dr. Gary Wingenbach, Dr. Theresa Murphrey, and Dr. Manuel Piña of the Department of Agricultural Leadership and Development; and Dr. Edwin Price of the Department of Agricultural Economics and Director of the Center for Conflict and Development, all located at Texas A&M University during this study.

I have heard over the course of my dissertation studies that a six-member committee can be cumbersome and, to some, even ill advised. While I see why one would consider this reasoning, as a larger committee implies more prelim exams, more busy people to schedule meetings and communicate with, and more discerning individuals with the prerogative to sanction the research and activities, that a large committee was awkward or burdensome has not been my experience. Each of my committee members, experts in their specific field of study and scope of work and dedicated in their own way to positively impacting the advancement of science, education, and development, has contributed significantly to my growth as a person, development agent, scientist, global citizen, and life-long learner.

Dr. Lombardini swears English is his second language (Italian being his first), yet he is the best writer and editor in English I can think of. He allowed me the freedom to explore my own ideas and helped navigate the world of funding, office and industry

politics, personal life events, and much more in order to achieve this project. Dr. Hall added the horticultural-economic perspective, with supportive yet eagle-eyed discernment and the gusto to keep momentum high during the writing process. Dr. Wingenbach, my interim and original TAMU advisor, has held the bar high in regard to research and writing, pushing to achieve the highest potential. Dr. Murphrey, always willing to jump into the trenches, helped me understand the basics and details of qualitative research methods and formulate the theoretical framework. Dr. Piña gave insight into cross-disciplinary concepts, self-reflection, project evaluation and grant writing, and taught me to be sure my questions, objectives, and outcomes are always aligned. Dr. Price shared his vast knowledge of tangible and theoretical aspects of development and inspired me to get started on my 40 potential years as a productive agent of change.

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The following results are the product of hundreds of hours of study and planning, and collaborations that spanned across borders, disciplines, and languages – all with the goal of being able to most accurately depict the real-life issues faced by smallholder coffee farmers in San Pedro Yepocapa, Guatemala.

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CHAPTER I

INTRODUCTION

Coffee, especially the Arabica species (*Coffea arabica*), has provided a crucial source of income to thousands of Central Americans for nearly 200 years and it is especially important to the livelihoods of indigenous communities in Central America and Mexico (Baca, Läderach, Haggar, Schroth, & Ovalle, 2014; Fischer & Victor, 2014). Guatemala's 277,000 hectares of Arabica coffee generate wages equivalent to nearly 70 million annual workdays, providing the largest source of rural employment in the country (Aguilar & Díaz, 2014; K. S. Morris, Méndez, Zonneveld, Gerlicz, & Caswell, 2016; Tay, 2017).

Coffee is also a booming business in consuming countries; the United States spends over $70 billion on coffee products in a single year (Talhinhas et al., 2017). Total economic output including ancillary products and services has reached $225.2 billion, equivalent to 1.6% of US GDP (Technomic, 2016). Global consumption has also increased substantially, forecast to reach 167.9 million 60-kilogram bags[1] by the end of 2019 and projected to continue rising in coming years (Halstead, 2018, 2019). Yet, while highly valued for significant cultural and economic importance, there are significant issues affecting coffee's continued production. Recently, climatic changes have created favorable conditions for harmful pathogens that reduce yield and quality, causing instability within

[1] The 60-kilogram "bag" is a unit defined by the International Coffee Agreement of 1962, which, among many other things, developed a glossary of standardized terms to facilitate communication between producing and consuming countries.

the industry and reducing profitability for producers (Bertrand et al., 2012; Gay, Estrada, Conde, Eakin, & Villers, 2006; Jaramillo et al., 2009; Läderach et al., 2011; Ovalle-Rivera, Läderach, Bunn, Obersteiner, & Schroth, 2015; Watts, 2016).

The fungal pathogen *Hemileia vastatrix*, which produces a leaf-borne disease known as coffee leaf rust disorder (CLR), is considered coffee's largest single global challenge (Avelino et al., 2015; Schieber & Zentmyer, 1984; Talhinhas et al., 2017). Coffee leaf rust has negatively impacted production and profitability for thousands of coffee farmers, both historically (McCook, 2006; McCook & Vandermeer, 2015) and recently (Bunn, Läderach, Rivera, & Kirschke, 2015; Eakin, Tucker, & Castellanos, 2006; Gresser & Tickell, 2002; Magrath, 2014b). As an example of the scale of threat CLR poses, it caused such widespread damage to Arabica coffee plantations on the island of Ceylon (now Sri Lanka) in 1869, and in the Philippines in the 1880's, once the first and third most productive global coffee regions, respectively, that it essentially wiped out all production and the coffee industry ceased to exist in either location (Conway, 2019; McCook & Vandermeer, 2015; *Philippine coffee* 2019).

In Central America the fungus has been present as an annoyance but not a major pest since the 1980's (McCook, 2006; Vandermeer, Jackson, & Perfecto, 2014). However, in 2012-2013 unusually warm, wet weather conditions brought its incidence to epidemic proportions, destroying 20% of the overall coffee crop and resulting in the loss of 337,000 jobs (Georgiou, Avelino, & Imbach, 2014; McCook & Vandermeer, 2015; Tay, 2019; USAID, 2018a). By other accounts, regional production volumes were 16% lower in 2013 than they had been in 2011 (Avelino et al., 2015), and Guatemalan exports were 40% lower than average that season, representing a decrease of 1.5 million bags (FEWSNET,

2013). In Guatemala the epidemic was estimated to have affected 70% of all coffee farms (Anzueto, 2013; FEWSNET, 2013), reducing individual farm yields by 30% on average and by up to 100% where unmanaged (Bielecki, 2015). This was devastating to the industry in Guatemala, especially in resource-poor populations and rural areas where coffee is the main source of income (Avelino et al., 2015; Tucker, Eakin, & Castellanos, 2010). These types of losses, in turn, affect international coffee markets (Halstead, 2017; McCook & Vandermeer, 2015; Talhinhas et al., 2017; Tay, 2017) and have been especially damaging for the small farmer, who often has low access to resources and formal education to call on in combatting and recovering from threats like CLR (Bathfield, Gasselin, García-Barrios, Vandame, & Lopez-Ridaura, 2016; Blundo Canto, Perez, Zuluaga Gonzales, & Läderach, 2015; FEWSNET, 2013).

Climate change is projected to continue negatively affecting coffee production, reducing the availability of suitable land 50% by the year 2050 and increasing the potential for CLR and other diseases to reduce cup quality (value) and productivity (volume), the two factors that most readily affect producer income (Bunn et al., 2015; F. b. M. DaMatta, Avila, Cardoso, Martins, & Ramalho, 2018; Läderach et al., 2013; Läderach et al., 2011; Ovalle-Rivera et al., 2015; Watts, 2016). Reduction in profitability, combined with a lack of available resources, threatens thousands of already precarious livelihoods and many producers have moved away from coffee production altogether (Bunn et al., 2015; Eakin et al., 2006; Gresser & Tickell, 2002; Magrath, 2014a; Tay, 2018). This shift and the implications of future climate change create a serious concern for the coffee industry, which is dependent on the 25 million smallholder farmers who dedicate their land and family labor to producing 80% of the world's coffee each year (FEWSNET, 2013; Gresser

& Tickell, 2002; Potts et al., 2014). Recent popular press articles (Gustin, 2019; Kepes, 2019; Semple, 2019) and nascent scientific investigations (Montgomery, 2019; Nevins, 2007) have articulated a strong correlation between disasters in the coffee sector and conflict, migration, and emigration in Central American nations. Guatemala is specifically cited in much of this work due to both the severity of impact of CLR on coffee, and of the coffee industry on livelihoods (McQuillan, 2019; Stanislijevic, 2019; Tucker et al., 2010).

Although smallholder farmers are an important force within the industry, they inherently experience low access to resources and face difficulty adapting in a changing climate (Vellema, Casanova, Gonzalez, & D'Haese, 2015; Vignola et al., 2015b). In response to the climate and disease pressures facing coffee, and to the challenges faced by smallholder farmers, many research and development agencies are focusing on the introduction of climate-smart and climate-resilient agricultural practices with the idea that these reduce risk by increasing production, improving product quality and maximizing potential profits, while avoiding harmful impacts on the environment (Lamanna, Kimaro, Arslan, Corner-Dolloff, & Rosenstock, 2018; USAID, 2018b; Vanlauwe et al., 2014). Of the suggested solutions, sustainable intensification through renovation with improved varieties is the most highly recommended to support increased productivity and profitability for smallholder coffee farmers in the face of climate change and CLR (Kilambo, Rebeun, & Mamiro, 2013; McCook & Vandermeer, 2015; Silva et al., 2006; Talhinhas et al., 2017).

Breeding programs have produced new coffee hybrids with resistance to CLR, along with high productivity and good cup quality (Montagnon, Marraccini, & Bertrand, 2012; van der Vossen, 2009). Projects such as the USAID-funded 3-year, $4 million

Resilient Coffee for Central America, 4-year, $4.5 million *Revitalizing the Central American, Caribbean, and Peruvian Coffee Sectors after the Rust Crisis of 2012 Through Applied Research and Development*, and 5-year, $36.4 million *Maximizing Opportunities in Coffee and Cacao in the Americas (MOCCA)* are introducing newly developed coffee hybrids into smallholder communities known to struggle with low productivity and profitability (Norton, Cole, & Lombardini, 2017; Technoserve, 2018; USAID, 2018c).

Initial success of these efforts (and therefore efficient use of time and funds) depends on recipients developing positive perceptions of the hybrids. Considering the resource poor regions in which these projects take place, optimism of the farmers towards the newly introduced plants needs to be substantial for adoption to take place; perceptions must be sufficiently positive that resource-poor farmers are willing to renovate their land and replace existing varieties with the more recently developed, unfamiliar hybrids. Such renovation involves freeing field space, planting each individual plantlet into prepared ground, providing adequate nutrition and pest management, and continuing this cultivating through multiple seasons (likely under field management practices that vary from historically utilized, familiar methods) until maturity is reached, all the while investing scarce resources. Further success of development efforts depends on the hybrids actually expressing the cited characteristics of higher productivity, resistance to disease, and good cup quality, and, importantly, that they do not require unsurmountable investment by producers to achieve these. Ultimately, the coffee must be successfully sold in either substantially higher volumes and/or at better prices than the status quo.

The present study focused on gaining a better understanding of initial perception stages, when farmers learn about and form opinions of newly introduced hybrids. These

early stages in the adoption process were selected for their importance as the foundation on which further project success is built and for their inference on successful, positive interactions between development projects and the populations they aim to serve. Further success of the hybrid intervention(s) depends on outcomes of these initial stages. Therefore, we aimed to move the needle towards closing the gap in knowledge about what factors, if any, have a particularly substantial impact on the perception-forming process of smallholder coffee producers towards new coffee hybrids introduced through development interventions.

The *Sustainable Incomes Through Coffee Farming Improvement* (SICFI) project was funded by The Starbucks Foundation and carried out between 2015 and 2018 by World Coffee Research (WCR) and Anacafé, the Guatemalan National Association of Coffee, in the region of San Pedro Yepocapa, in the Department of Chimaltenango, Guatemala. Over July and August of 2016, the project provided six organizations[2] of smallholder coffee farmers that had been highly affected by the CLR epidemic with the F1[3] coffee hybrid 'Centroamericano' (sometimes referred to as 'H1'). 'Centroamericano' was bred for rust-resistance, high productivity and good cup quality, characteristics projected to help the Yepocapa farmers overcome socioeconomic devastation wrought by CLR. While benefits of the hybrids may be quickly apparent to some, adoption of new technologies,

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[2] The terms "association" and "organization" will be used interchangeably throughout this document to refer to the six associated smallholder coffee farming institutions observed in this study.

[3] F1 hybrid varieties are created by crossing genetically distinct pure-line parents. The offspring of the cross are the first generation, "filial 1" (F1) hybrids. F1 hybrids are notable because they tend to have significantly higher production than non-hybrids, while maintaining high cup quality and disease resistance, yet offspring from these plants are not guaranteed to have all the same characteristics as some genes can be lost in breeding or unexpressed in further generations.

depending on such factors as farmer characteristics and socioeconomic context (Rogers, 2010), is notably difficult for smallholder and resource-poor farmers. Due to these constraints, and implications of lessons learned for future projects of similar nature, an evaluation of the factors affecting intent to uptake the hybrids was carried out during the second half of the SICFI project, with most of the data collection taking place in 2017.

Statement of Problem

As development projects aim to help Guatemalan producers overcome socioeconomic devastation brought by CLR, there is a need to examine smallholder perceptions of the 'Centroamericano' coffee hybrid as a viable solution to ameliorate the negative effects of this harmful fungal pathogen.

Research Objectives

The primary goal of the present research was to evaluate factors affecting selected Guatemalan smallholder coffee farmers' perceptions of, and intention to adopt, the 'Centroamericano' coffee hybrid[4] as an innovation to mitigate negative effects of CLR on farm-level productivity and profitability. Specifically, this project sought to ascertain: 1) the perceptions of Guatemalan smallholder coffee farmers regarding the 'Centroamericano' coffee hybrid; 2) the specific characteristics of the 'Centroamericano' coffee hybrid that influenced farmer perceptions about them; 3) aspects (if any) of the SCIFI project that significantly influenced farmer perceptions regarding the 'Centroamericano' coffee hybrid; and 4) whether Guatemalan farmers' intent to adopt the

[4] It is important to note that the study aimed to ascertain whether or not the farmers *intended* to adopt the hybrids, not whether they actually implemented or adopted them, nor whether the hybrids improved profitability.

‘Centroamericano’ coffee hybrid can be explained by the knowledge and persuasion stages of Rogers’ innovation-decision model.

Theoretical Framework

Adoption of Innovation: Rogers model

The theoretical framework employed in this study is built on Rogers (2010) model titled *Stages in the Innovation-Decision Process*. Rogers describes the process by which an individual decides to adopt or reject a new innovation as a stepwise, five-stage progression that occurs in a cumulative sequence over time. This model, well-known due to its versatility as a foundational theory of human nature, has been cited hundreds of thousands of times in the literature[5]. For example, it has been used in analyzing the adoption and diffusion of innovations and technologies in such diverse contexts as agriculture and life sciences (Lynch, Gregor, & Midmore, 2000), the social media platform Twitter (Chang, 2010), nursing (Pashaeypoor, Ashktorab, Rassouli, & Alavi-Majd, 2016), curriculum development (Phillips Janet et al., 2013), health organizations (Goldman, 1994), mobile banking (Kim, Shin, & Lee, 2009), vernacular architecture (Al-Qawasmi, 2014), communication and information technologies (Minishi-Majanja & Kiplang'at, 2005), the local food movement (Inwood, Sharp, Moore, & Stinner, 2009), feminine hygiene (Jacob, Khanna, & Yadav, 2014), and many other sectors. Though Rogers original work was developed by investigating perceptions and decision-making of swine and corn farmers in the US states of Iowa and Ohio (Rogers, 1958), it has been applied to myriad international

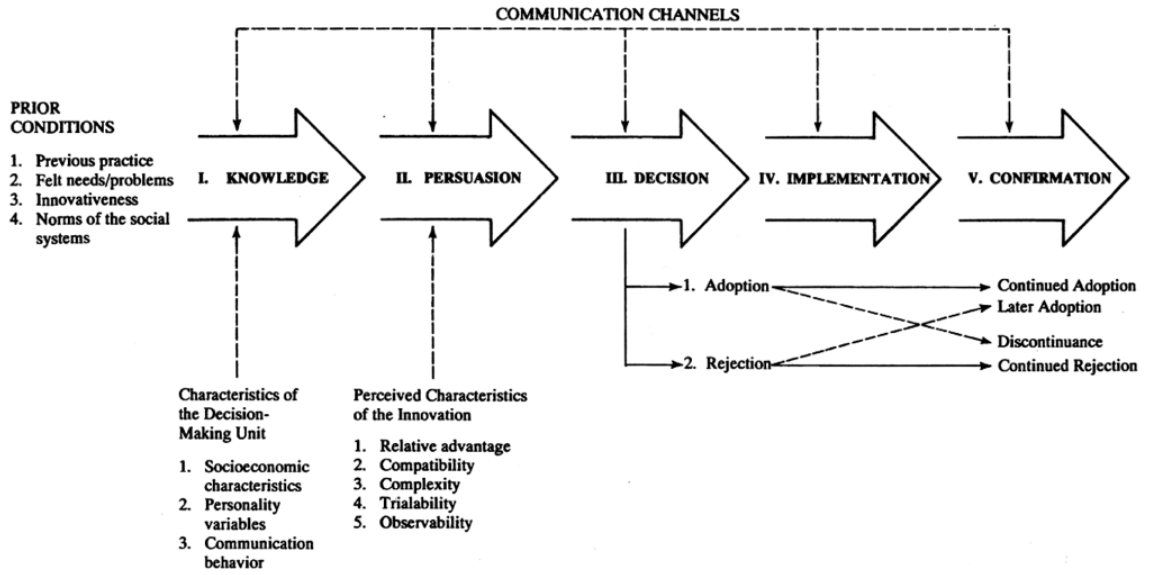
[5] At the time of writing (August 2019), the 5th (2010) edition of Rogers’ book *Diffusion of Innovation* had been cited 106,262 times in Google Scholar.

and global contexts (Chang, 2010; Dearing, 2009; Jiménez & Zheng, 2018; Kassangoye & Rugimbana, 2013; Minishi-Majanja & Kiplang'at, 2005), as well as resource poor and smallholder contexts (Bellwood-Howard, 2013; Gollakota & Doshi, 2011; Jacob et al., 2014; Kulecho & Weatherhead, 2006; Kuntosch & König, 2018; Okello, Zhou, Barker, & Schulte-Geldermann, 2019).

Kaimowitz, Snyder and Engel (1990) define a "new technology" as something that was either recently developed or which is being introduced to a new region or population. Rogers (2010) specifies that "newness" of an innovation is based on the perception of the adopter, not "new as measured by the lapse of time since its first use or discovery," and implies an inherent level of uncertainty for potential adopters (p. 12). The terms technology and innovation will be used interchangeably in the proceeding text (Rogers, 2010).

Rogers' (2010) model delineates and describes five major stages along the adoption continuum, each named for behavior commonly observed throughout that stage. Some stages are more affected by external inputs (e.g., information about the innovation provided by an outside source), but all describe the internal process an individual goes through in "dealing with the uncertainty that is inherently involved in deciding about a new alternative to an idea previously in existence" (p. 168). The five stages are described as follows: 1) *knowledge,* when an individual becomes aware of the existence of an innovation or technology; 2) *persuasion*, in which the potential adopter develops an attitude towards the newly learned of innovation; 3) *decision*, in which a conclusion is made whether to accept or reject the notion of the innovation; 4) *implementation*, when the

technology is put to use or not; and 5) *confirmation*, when the decision to adopt or reject is ultimately reinforced through more prolonged engagement (Figure 1).



The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

Figure 1. Rogers' Model of the Five Stages of the Innovation-Decision Process[6].

The present study applied the first two stages of Rogers' model – knowledge and persuasion – to the case of smallholder coffee farmers becoming aware of and forming an opinion about the 'Centroamericano' coffee hybrid. According to the model, the decision to adopt or reject an innovation or new technology is founded in these two stages, which provide the basis for further decision making, action, and confirmation (Rogers, 2010). In

[6] From DIFFUSION OF INNOVATIONS, 5E by Everett M. Rogers. Copyright © 1995, 2003 by Everett M. Rogers. Copyright © 1962, 1971, 1983 by The Free Press. Reprinted with the permission of The Free Press, a Division of Simon & Schuster, Inc. All rights reserved.

other words, the introductory stages of knowledge and persuasion have direct effect on whether the following stages of adoption take place, and in which direction they go – toward adoption or rejection. Additionally, aspects of these initial stages (e.g., when introductions are made, and information is shared) fall within the power of development projects to customize; development agents can feasibly plan their initial project activities in such a way as to minimize known obstacles specific to the cultural or socioeconomic context. Adoption may or may not take place after these first two stages, based on many variables, but a person's first introduction to an idea or innovation is often the most important in establishing their lifelong perception of that innovation or technology (Furnham & Boo, 2011). Termed the "anchoring effect," this phenomenon was first described by Tversky and Kahneman (1974) and is often so binding that, once in individual has developed an opinion around something, subsequently obtained information (even that which negates their position) may be misconstrued, ignored, or cherry-picked to support their existing stance, in what is known as "confirmatory bias" (Rabin & Schrag, 1999).

Rogers Model Stage I: Knowledge

In the Rogers model there are three types of knowledge that are critical for efficient decision-making: *Awareness knowledge,* obtained when the individual becomes cognizant of the existence of the innovation; *How-to knowledge*, which includes the information necessary to use the innovation properly; and *Principles knowledge*, which involves an understanding of how the innovation works. According to Rogers, a lack of how-to knowledge often results in rejection, whereas a lack of principles knowledge may lead to misuse of the technology.

Rogers Model Stage II: Persuasion

During the persuasion stage the potential adopter evaluates the innovation and forms an attitude towards it, taking into account its perceived characteristics. Rogers (2010) describes five characteristics of the innovation that most affect its favorability and rate of adoption, including relative advantage, compatibility, complexity, trialability, and observability. Relative advantage and compatibility are positively correlated with acceptance, while complexity is negatively associated. Innovations that can be readily and easily trialed and/or observed are also more likely to be adopted.

Delimitations

This study was delimited to six smallholder coffee growing associations in the region of San Pedro Yepocapa, in the Department of Chimaltenango, an important coffee-producing region for the country of Guatemala. The selection process for these six associations is discussed in detail in Chapter 3. Data were collected with the objective of describing how farmers in these associations perceive adoption of the 'Centroamericano' coffee hybrid as a means of countering the effects of CLR. Four lines of inquiry were employed: 1) obstacles to production of coffee experienced by these farmers, 2) obstacles to the sale of coffee experienced by these farmers, 3) farmer perceptions of the Centroamericano coffee hybrids, and 4) characteristics of the SICFI project that positively or negatively influenced farmer perceptions of the hybrids. Perception data were collected during focus groups held between August 21 and September 1, 2017, thus are reflective of conditions in Guatemala and the coffee industry at that time. Qualitative data were

collected through focus group interviews with community members, conversations with SICFI project administrators from World Coffee Research and Anacafé, observations during site visits, prolonged exposure of the principal investigator to Guatemala and the Guatemalan coffee industry, and discussions with other development agents in the region.

Limitations

There were a number of aspects of this study that potentially limit its global representativeness. First, data were collected only in the San Pedro Yepocapa region of Guatemala, and thus are restricted to experiences of farmers living and producing coffee in this region and country. It is expected, however, that the findings can be at least partially extrapolated to other areas, but no specific evidence can be provided that this is the case. The region and farmer organizations were chosen for participation in the SICFI project by experts at Anacafé due to 1) being one of two regions of Guatemala most affected by CLR during the 2012-2013 epidemic and 2) being home to smallholder coffee farmers with low access to resources and little recourse against the CLR epidemic (Schilling, Montagnon, & Lombardini, 2015). Through involvement in the project some smallholder coffee farmers in Yepocapa were given the opportunity to receive the Centroamericano coffee hybrid, and therefore went through the process of forming an opinion about both the hybrids and the project, thus presenting the phenomena that is the focus of this study.

Second, data for each association were collected during focus groups, which were attended by a selection of members of that association and reflect experiences of the farmers in attendance. To account for any potential biases resulting from this, two focus groups were implemented per organization, the first including a group of farming associates and the second including the members of the Board of Directors of that

organization, who reviewed and supplemented the work of the associates, providing a member check of the information.

The lead researcher made every attempt to gather data reflective of obstacles affecting the farmers throughout their history in coffee production and marketing, including the specific impacts that were experienced in the years during and shortly after the CLR epidemic. A qualitative, instrumental, multisite case study approach was used to describe the context in which these farmers live, and to identify farmer perceived issues in the production and marketing of coffee, as well as any characteristics of the SICFI project that affected receptiveness to, and implementation of, the 'Centroamericano' coffee hybrids (Merriam, 2009).

Assumptions

In conducting the qualitative analyses, it was assumed that the subjects: a) responded truthfully to questions asked by the principal investigator and research team; b) did not withhold important information when asked questions by the principal investigator or research team; c) did not modify their behavior in the presence of the principal investigator or research team; d) did not modify physical conditions of dwellings or coffee parcels in the presence of the principal investigator or research team; and e) did not selectively demonstrate parcels or other phenomena to hide some aspect of the full context.

Forthcoming, the remainder of this dissertation is structured along the following lines: Chapter 2 includes a literature review regarding the coffee industry in Guatemala, historic driving forces of structural change in smallholder coffee farming, impacts of and responses to CLR, development of the SICFI project, obstacles specific to resource-poor farmers, and the underlying bases for the present research. Chapter 3 introduces the

methodology used to select and recruit subjects and conduct the focus group data collection, provides literature supporting the appropriateness of these methods to the study context, and describes the data analysis. Chapter 4 presents the results of these analyses. Chapter 5 provides conclusions and discussion, including comparison of results to the Rogers' innovation-decision model. Chapter 6 culminates with recommendations for future research and development efforts of this type.

CHAPTER II

LITERATURE REVIEW

Introduction to Coffee

Botanical description

Coffee is a woody, perennial shrub from the family Rubiaceae. The terms "shrub" and "tree" are used interchangeably in reference to the plant, reflecting its woodiness and relatively short stature[7] (Wellman, 1961). All known species originate from tropical Africa, with the Arabica species hailing more specifically from mountainous regions in the area now known as Ethiopia, Sudan and Kenya (Davis et al., 2019; Francis, 2007; Wintgens, 2012), referred to by some as the East African Highlands. There are over 100 cataloged species of *Coffea*[8] but the two of most importance to humans are *Coffea arabica*, known as "Arabica" and *Coffea canephora* var. *robusta*, commonly referred to as "Robusta" (Wintgens, 2012). Together, the Arabica and Robusta species account for about 98% of all coffee production and consumption, with the other 2% coming from the *C. liberica* and *C. excelsa species* (Davis et al., 2019). Flavor profiles produced by Arabica are considered more desirable and valuable of the two (Arabica coffee generally sells for at least twice the price of Robusta) and thus makes up roughly 60% of global production, despite being more

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[7] Plants of the Arabica varieties average between 2.5 and 4.5 meters (~8 to 15 ft) in height

[8] Until recently, the *Coffea* genus included 104 species distributed in the sub-Saharan Africa. In 2011, Davis et al. published a study which determined that, based on their research and systematically informative and morphological evidence from a broad range of studies, the genus *Psilanthus*, which included 20 species occurring from West Africa to northern Australia, should be subsumed into *Coffea*. This decision increased the number of species in *Coffea* from 104 to 124 and extended the distribution of the genus to tropical Asia and Australasia.

susceptible to heat stress and most of coffee's major soil-borne and aboveground insect and fungal pests (Davis et al., 2019; van der Vossen, Bertrand, & Charrier, 2015).

In botanical terms, the coffee fruit is considered a drupe, or drupaceous berry[9], but is commonly referred to as a "cherry" in English (Wintgens, 2012), and *uva* in Spanish, which directly translates as "grape." A fresh, mature coffee cherry looks similar in size and shape to a cranberry – oblong, rounded on the ends, and smooth on the surface with a thick, leathery epicarp (outer skin) that can be red, pink or yellow in color. All major layers of the pericarp are visibly discernable: epicarp (outer skin), mesocarp (fleshy pulp) and endocarp (parchment), and an integument (silverskin) also covers the seed. In post-harvest preparation of washed coffee there is often a processing step dedicated to the removal of each of these layers individually, with the fine silverskin coming off during roasting.

Within the cherry are two ovoid seeds, each with a flattened side where it faces the other and a rounded side that points outward, resulting in the familiar half-oval coffee bean shape. When removed from the fruit and dried to around 10% water content (depending on the buyer, this requirement can range between 9-13%), these seeds are greenish-grey in color and can remain viable as a commercial product for up to 2 years (Davis et al., 2019). Undamaged, Robusta and Arabica coffee seeds are physiologically viable – meaning they respire, digest stored energy, and can successfully germinate – for approximately two and six months respectively (Wintgens, 2012). Coffee trees tend to produce their first fruit at

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[9] Botanically, a "berry" is a simple fleshy fruit produced from the ovary of one single flower. The term "drupe" is the botanical synonym to the common term "stone fruit," referring to an indehiscent fruit with a hard pit at the center, such as a mango or avocado. As there is not always a clear delineation between berry and drupe, a berry can be referred to as "drupaceous" to signify the presence of a relatively large, lignified central seed.

around 3 years of age, with full production occurring between years 4 and 6 (Wintgens, 2012).

Genetics

All known *Coffea* species are diploid (having two sets of chromosomes) except for Arabica, which is uniquely tetraploid (having four sets of chromosomes), thought to be a result of its inception as a hybrid offspring of *C. canephora* and the species, *C. eugenoides* (Charrier & Berthaud, 1985; Philippe, Benoít, & Hervé, 2009). Arabica coffee can self-fertilize, even prior to flower opening, while Robusta must be cross-pollinated (Carvalho & Ferwerda, 1969; Carvalho & Monaco, 1969). Taxonomic surveys have identified a severely restricted gene pool in cultivated Arabica coffee, a direct result of its historical movement out of East Africa being limited to a handful of individual plants that made their way to botanical gardens in Europe, seeds from which were eventually brought to Latin America (Carvalho & Monaco, 1969). In his World Crops Book, *Coffee: Botany, Cultivation and Utilization,* Wellman (1961) described a genetic bottleneck so extreme that "it can be logically concluded that, practically speaking, all Arabica coffee of commerce has come originally from one tree… the eccentric dwarfs, giants, growth and colour variants, that have mutated from plantation growths, are still basically the same strain" (p.39). This is of concern because it limits the potential to gain new traits through breeding, and because genetically similar individuals are likely to be uniformly susceptible to pathogens.

Physiology and Biophysical Requirements

Cultivation of Arabica coffee in Central America is found in well-defined, albeit widely separated areas, generally at altitudes between 3,000 and 5,000 feet (~900 to 1,500

meters above sea level [masl]). It is not uncommon to find plantations at elevations as high as 6,000 feet (~1,800 masl), but this is the exception rather than the rule. Arabica growth, productivity, and cup quality are intimately dependent on temperature, and are limited to a range of 64-70 °F (18-21 °C) (M. Scott, 2015). Arabica plants cannot survive where frosts occur nor can they be grown successfully where average temperatures are greater than 77 °F (25 ºC), as excessive heat develops the wood of the tree at the expense of the fruit and the seed in this case is almost assuredly of poor quality (F. M. DaMatta, Ronchi, Maestri, & Barros, 2007). Thus, in the lowland areas of Central America, where the temperatures can approach 95 ºF (35 ºC), it is too hot for successful Arabica production and very little is grown there, instead being concentrated at the higher altitudes previously mentioned.

Coffea canephora occurs wild in the equatorial forest from West Africa to Lake Victoria, in a region that spans from 10° north to 10° south of the equator, and from sea level to 1,500 masl. Because of these natural origins it prefers warmer conditions 75-85 °F (24-30 °C) with less contrasting dry and rainy seasons (F. M. DaMatta, Chaves, Pinheiro, Ducatti, & Loureiro, 2003; Nair, 2010; Purseglove, 1968). Robusta seeds have double the caffeine content and a more bitter flavor (Smith, 1985), and are commonly mixed with Arabica to produce mid-quality or espresso blends, in the making of freeze dried crystals, and for caffeine extraction, accounting for nearly 40% of global production (Davis et al., 2019). Robusta has a wider temperature and elevation range and resists most of the above and below ground disease pressures to which Arabica is susceptible (Davis et al., 2019; Waller, Bigger, & Hillocks, 2007). For these reasons, Arabica-Robusta hybrids, which may contain the higher temperature and disease resistance of Robusta, and at the same time the

more delicate flavor profiles of Arabica, are of great interest to the industry (Wintgens, 2012).

Varieties of the Arabica species generally require a minimum annual rainfall of approximately 70 inches (178 cm); desirable rainfall distribution includes a rainy season, in which the coffee berries form and mature, and a dry season that provides conditions for the final maturation, harvesting, processing and curing of the berries (Purseglove, 1968). The interior tablelands and the Pacific slopes of Guatemala have a distinctly seasonal rainfall. For about six months there is a dry season during which there is little precipitation. However, like most of Central America, Guatemala receives daily convectional showers during the rainy season that occurs between May and October. In some coffee producing regions there are a few quick rain showers in the weeks prior to the rainy season, referred to as "flower showers" because they spur the coffee into initial flowering stages (Carvalho & Monaco, 1969), usually within 3-10 days after the precipitation event (Wintgens, 2012). A distinct dry season, along with timing and intensity of the flower showers, is crucial to flower set, and to timing and intensity of flowering and fruit production (Wintgens, 2012). Precipitation and dryness have such impact on physiology that coffee grown in areas with more consistent rainfall produces fruit year-round, exhibiting up to 25 and even 50 different flowering/fruiting periods in a single year (Wellman, 1961; Wintgens, 2012). Consistency of showers during the rainy season is also an important factor, as coffee trees need an abundant, regular moisture supply during fruit development to reach their highest potential in yield and cup quality. Just after flowering, and throughout the rainy season, tiny cherries known as pinheads develop from the fertilized flowers, filling in and becoming full sized fruit over the course of about six months (Wintgens, 2012). By

September, the rainfall diminishes and favors maturation of the berries, which become bright colored and are harvested, processed, cured, and marketed to buyers over the following five to six months.

Coffee trees are usually maintained in a standard "central leader," or "modified central leader" pruning form (Reed, 1993), with one to four main stems and simplistic lateral branching, on which the fruit is produced (Wellman, 1961; Wintgens, 2012) (Figure 2). Not all of a plant's cherries become ripe at the same time, instead usually ripening in clusters closer to the apex of the branch to start, with successive ripening toward the primary stem (Figure 3). Because of this phased ripening, coffee must be picked from each plant multiple times throughout harvest season, usually every couple of weeks, until all ripe cherries are off the tree. Cherry maturation is generally slower at higher elevations where temperatures are on the low end of the acceptable range, thought amongst roasters and consumers to lead to more sugar formation in the bean and ultimately a higher cup quality (Newton, 2018). Correlations between elevation and cup quality have been substantiated to some degree through scientific study, though flavor profile and cup quality are ultimately a result of many genetic, environmental, time-of-harvest, and postharvest factors (Alpizar & Bertrand; Cheng, Furtado, Smyth, & Henry, 2016; Worku, De Meulenaer, Duchateau, & Boeckx, 2018). Still, green coffee going to market is often discussed in terms of elevation as a proxy for quality; in Guatemala, descriptors like "hard bean" and "strictly hard bean" are associated with elevation range, expected quality, and price paid by buyers.

Figure 2. Coffee cherries growing in clusters along a lateral branch.

Figure 3. Phased ripening of coffee cherries, with more mature, red berries on the branch apex and less mature, greener ones closer to the main plant stem.

Impacts of Climate Change

As was stated in the introduction, impending climate change threatens to make things worse for producers around the world as temperatures rise and weather patterns change (Bacon, Sundstrom, Stewart, & Beezer, 2017; Blundo Canto et al., 2015; Fischer & Victor, 2014; Läderach et al., 2017; K. S. Morris et al., 2016; Schroth et al., 2009), materializing in the form of atypical rain patterns, coastal erosion, increased storm intensity, and migration, loss, and instability within plant and animal species (Howden et al., 2007; IPCC, 2014). Recent modeling efforts predict that, as a result of these changes, land suitable for coffee cultivation will decrease by as much as 50% in a matter of just a couple decades (Läderach et al., 2017; Ovalle-Rivera et al., 2015), risking the loss of an important means of income for hundreds of thousands of coffee farmers (USAID, 2018c). Fluctuations in rain pattern, such as drought during the rainy season or odd timing of flower showers, is already of great concern and a growing problem affecting yields in the majority of coffee producing countries (Ovalle-Rivera et al., 2015). Climate tracking shows that areas where the highest quality Arabica coffee is produced are now warming, creating a conducive environment for coffee leaf rust and other pests, impacts of which are likely to be heaviest at lower elevations and latitudes (Bunn et al., 2015; Ovalle-Rivera et al., 2015). Additionally, and likely as devastating for coffee's future production, climate change may severely reduce the land area naturally habited by wild Arabica coffee, causing the loss of these important sources of genetic variation before the end of the century (Davis et al., 2019; Davis, Gole, Baena, & Moat, 2012). Both industry and

scientists are seeking strategies to address such potential catastrophe (Rosner, 2014; Watts, 2016).

Coffee Leaf Rust

The fungal disease *Hemileia vastatrix*, commonly known as coffee leaf rust (CLR) or "roya" in Spanish, poses the single greatest global threat to Arabica coffee (Talhinhas et al., 2017; Wintgens, 2012). The obligate parasite causes loss of healthy photosynthetic leaf area[10], reducing the plant's ability to perform important physiological functions (McCook, 2006; Waller et al., 2007). After making its way to the leaf surface, CLR invades through stomatal pores on the underside (abaxial surface) of the leaves, inserting a hyphal foot through the stomatal aperture and expanding from there to further overtake the leaf tissue (Arneson, 2000). An infection first appears as yellow spots, which eventually appear orange and powdery as spores mature (Arneson, 2000; Waller et al., 2007) (Figure 4). Infected leaves are not as able to photosynthesize effectively, and in many cases eventually fall from the tree, sometimes defoliating the entire plant (Figure 5).

[10] For a good description of photosynthesis, see the dedicated plant physiology chapter in any edition of Reece et al.'s textbook, *Campbell Biology*.

Figure 4. A coffee leaf showing orange pustules, a clear sign of CLR infection. Necrotic (dead) tissue is evidence of severity or secondary infection.

Figure 5. Defoliated branches of a coffee tree heavily infected with CLR.

CLR infections usually peak during the harvest season when the coffee cherries are already present and mature, therefore yield loss is often less prominent during the first year of infection, but becomes more so, and can even double, in following years when the plants remain compromised (Avelino et al., 2015; Cerda et al., 2017; Talhinhas et al., 2017). Spore germination is reliant on the presence of water on the leaf surfaces, which must persist for 24 to 48 hours for full leaf infection to take place (Arneson, 2000). CLR rarely kills its host outright but can cause up to 90-100% reduction in yield (Bielecki, 2015; McCook, 2006), with annual global losses already estimated at 15-80% in 2007

several years prior to the Central American epidemic (Waller et al., 2007). In addition, CLR damage may leave the plant vulnerable to infection by other diseases, which can compound yield loss and cause full plant mortality (Flood & Day, 2016). An observation of the most recent epidemic was that the effects seemed to occur in the same year as the infestation, possibly due to an evolved shortened segment of the CLR life cycle (Mabbett, 2018).

History in Latin America

CLR was first observed in Brazil in 1970, most likely brought over from Africa by human carriers, and by 1975 it was present in almost every Brazilian coffee growing region (Waller et al., 2007). It arrived in Central America in the early 1980s causing fear that it would wreak havoc on coffee production (McCook, 2006; Talhinhas et al., 2017). Instead, it seemed to fold itself into the regular dull roar of pest incidence, not growing to a major threat in Central America until 2012, when it suddenly caused dramatic yield losses and became an epidemic across the region (Avelino et al., 2015; FEWSNET, 2013; Waller et al., 2007).

Epidemic of 2012-2013

The CLR epidemic of 2012-2013 caused millions of dollars in damages across Central America, reducing production by 16% relative to 2011 levels according to at least one study (Avelino et al., 2015), and affecting over 70% of all Guatemalan coffee plantations (FEWSNET, 2013; OXFAM, 2014). Thousands of farms were devastated, throwing laborers and families into extreme poverty and warranting the declaration of a national emergency and several million dollar UN donation (International Coffee Organization, 2013; Promecafe, 2016). Production losses were seen for multiple years after

initial onset (Avelino et al., 2015) and came on the heels of a period of extremely low market prices (Georgiou et al., 2014; Jha et al., 2011). The combination of low prices and CLR infestation reduced the export value of Central American coffee by 50% over the course of just two years (FEWSNET, 2013; McCook & Vandermeer, 2015). In many cases, smallholder farmers were left to decide whether to keep producing now seemingly vulnerable coffee as their primary cash crop, diversify their sources of income by investing in other crops, or simply move away from coffee farming altogether (Bielecki, 2015; Eakin et al., 2006; Gresser & Tickell, 2002). As a result of these challenges, many large-scale coffee producers did switch to other crops, leaving 98% of Guatemalan production to small farmers (Fischer & Victor, 2014; Tay, 2017; Tucker et al., 2010). Guatemalan coffee production in general has decreased by 3% annually since 2013 as each year less land is dedicated to coffee production across all farm sizes, a trend that is projected to continue, and likely worsen, in future years due to continued economic and climatic instability (Tay, 2017).

The Central American CLR epidemic of 2012-2013 has been linked with climate change in the scientific literature (Avelino et al., 2015; International Coffee Organization, 2017). It is thought that a combination of warmer, wetter weather and low market prices created "the perfect storm" for CLR to reach such proportions (Georgiou et al., 2014; OXFAM, 2014). Low return from coffee and an unstable pricing market restricted the ability of smallholder farmers to effectively and consistently respond to issues caused by climate change and they were not prepared to fight the CLR when the epidemic hit (Talhinhas et al., 2017; Tay, 2018). In response to the devastation from CLR and continued insecurity in coffee farming, the Guatemalan government and aid agencies have made

commitments to assisting in capacity building, with a focus on introducing the newest technologies on smallholder farms (Promecafe, 2014). Though there has been a demonstrative mitigation effort, CLR persists as a major problem in Central American coffee production (Halstead, 2017) such that, without further assistance, smallholder coffee farmers have slim chances of regaining healthy livelihoods (K. S. Morris et al., 2016).

Field Management of CLR

Various fungicides, such as those containing divalent copper, are effective in treating CLR but are expensive and create an environmental hazard as residues accumulate over time (Nyoro & Sprey, 1986b; Silva et al., 2006; Talhinhas et al., 2017). The high expense of chemical control measures prohibit their use by many producers and are one of the main contributors to reduced profitability where farmers do have the ability to source, purchase, and apply them (Waller et al., 2007). Stumping[11] can also be done to reduce CLR infestation, but the plants require a full 1-3 three year wait for regrowth and, in the meantime, if proper sanitation practices are not put into place, CLR will continue attacking the regenerating plants (Avelino et al., 2015). Stumping may not always be recommended even on healthy plants, as it causes a shock to the entire physiological system and in all cases requires a waiting period for continued fruit production, the length and severity of which is exacerbated by infertile soils, lack of rainfall, and inadequate shade (Wintgens, 2012). Since CLR reduces a plant's ability to form the sugars crucial to metabolic function,

[11] "Stumping" is a field management practice that involves cutting down the coffee tree, leaving about a foot (30 cm) of the trunk in place, and allowing this material to regenerate into a new tree.

leaving them starved for energy, infected plants are likely not good candidates for rapid or robust tissue regeneration after stumping.

Addressing the Issues

Resistant Varieties

According to McCook and Vandermeer (2015), "the main challenge for researchers [in supporting future coffee production] is to develop rust control strategies that are both ecologically and economically viable for coffee farmers" (p. 1164). Renovation of plantations with new, more productive, and resistant species and varieties has been recommended as a promising method to overcome coffee leaf rust for over a century, and in coffee production regions as diverse as Asia, Africa, and Latin America (Karanja & Nyoro, 2002; Kilambo et al., 2013; Nyoro & Sprey, 1986a, 1986b; Silva et al., 2006; Talhinhas et al., 2017; Valenzuela, 1929). Robusta's use rose after, and was likely even initiated as a result of, the decimation of the coffee industry in Ceylon and Indonesia between 1880 and 1890 (McCook & Vandermeer, 2015). In 1929, Valenzuela discussed replacing all Philippine Arabica coffee with Robusta, *C. liberica* and/or *C. excelsa* species, which were already well known to be more resistant to CLR (Valenzuela, 1929). In 1985 and 1986, the Coffee Research Foundation (CRF) in Kenya introduced the 'Ruiru 11' hybrid to farms of all sizes, which was intended to reduce the need for chemical treatment and low productivity due to CLR and other diseases (Karanja & Nyoro, 2002; Nyoro & Sprey, 1986a, 1986b). Contemporary conversations are still focused on the cultivation and dissemination of hybrids with genetic and phenotypic characteristics of both Arabica and Robusta, anticipated by many as essential to combatting CLR. Talhinhas et al. (2017) echoed this sentiment in their statement that "the use of resistant cultivars is considered to

be the most effective and durable [CLR] control strategy" (p. 1039). One of the first documented attempts to promote the use of hybrids against CLR was the introduction of the dwarf hybrid Ruiru 11, which is tolerant to CLR and resistant to coffee berry disease (*Colletotrichum kahawae*) to Kenyan smallholders (Nyoro & Sprey, 1986a) and coffee estates (Nyoro & Sprey, 1986b).

It has been reported that the new lines of coffee hybrids, specifically bred for resistance to disease and climatic fluctuations, high yield and good cup quality, have added ecological and socioeconomic benefits due to reduced use of chemical pest control (van der Vossen, 2009; van der Vossen et al., 2015). Gatzweiler and Von Braun (2016) recommend "making use of improved varieties and technologies adjusted to changing environmental and climatic conditions" as an important means of building capacity among smallholder farmers and addressing global food insecurity (p. 18). Not only do the improved varieties represent a means of overcoming the effects of disease and further climate change related issues in coffee, but the projects that introduce them also stand to improve the disadvantaged conditions of smallholder coffee farmers through the mechanism of targeted action against poverty reduction (Mendola, 2007). According to Irz, Lin, Thirtle, and Wiggins (2001), "it is unlikely that there are many other development interventions capable of reducing the numbers in poverty so effectively" (p. 449). Thus, rust-resistant coffee varieties provide a glimmer of hope that coffee will continue as an important crop in Guatemala and elsewhere, despite the many challenges currently facing the coffee industry.

Smallholder Coffee Farming

Defining the Smallholder

The term "smallholder" logically implies a land holding that is, in relative size, notably less substantial than other holdings. Indeed, a land area of 2-3 hectares (ha) or less is a common definition of smallholders (Karanja & Nyoro, 2002; Lowder, Skoet, & Raney, 2016; Morton, 2007). By one recent estimate, out of more than 570 million farms in operation around the world, upwards of 475 million are sized 2 ha or less, however these authors are clear that there are not sufficiently accurate data to be certain how closely these estimations reflect reality (Lowder et al., 2016). Smallholders are directly dependent on agricultural production for the income that supports their livelihoods (Donatti, Harvey, Martinez-Rodriguez, Vignola, & Rodriguez, 2019), and also characterized by intensive agricultural practices and higher use of human energy and family labor than other farming styles – more practical characterizations than land area (Morton, 2007; Netting, 1993). Also, it is important to note that, a descriptor such as "small" being fairly subjective, what constitutes as a small land holding in one part of the world (e.g. Latin America) would likely be seen as rather large somewhere else (e.g. sub-Saharan Africa) (Lowder et al., 2016; Rapsomanikis, 2015). For practical purposes (e.g., accounting, developing policy, calculating global distribution and impact on food production), the term "smallholder" should be correlated with socioeconomic characteristics instead of farm size. Characteristics like productivity, business structure, income, poverty, food insecurity, and cultural marginalization are more appropriate and helpful (Gatzweiler & Von Braun, 2016). Such terms reflect the extensive heterogeneity amongst smallholder farmers (Vanlauwe et al., 2014)

Smallholders and Climate Stressors

Smallholders are inherently susceptible to the negative impacts of a changing climate. Farming, in general, is more reliant on the natural environment than other occupations. If a drought, storm, or plague hits at an inopportune time, a farmer's product, and therefore livelihood, is directly affected (Karanja & Nyoro, 2002). Stability is an issue in general; bumper years for production and price, while positively oriented fluctuations, still reflect general instability which can complicate planning, investing, and marketing (Johnson, 2010). While some production systems have built-in mechanisms of resiliency and stabilization through being diverse, scaled, insured, or synthetically manipulated (e.g. the commodity system in the United States), smallholder farmers do not have such protections and are inherently vulnerable to environmental and market stressors. Barnett and Adger (2007) explain that "vulnerability (potential for loss) of people to climate change depends on the extent to which they are dependent on natural resources and ecosystem services, the extent to which the resources and services they rely on are sensitive to climate change, and their capacity to adapt to changes in these resources and services" (p.641). In addition to exhibiting many of these characteristics, a large portion of the world's smallholders are located in the tropics, where the effects of climate change are heightened (Harvey et al., 2014). Land size and resource availability do appear correlated with (in)ability to respond to fluctuation; Tucker et al. (2010) found that smallholder coffee farmers in Mexico, Honduras and Guatemala with less land, or who were poorer than others, were simply less able to make coping (short-term, reversible) or adaptive (long-term, irreversible) adjustments.

Smallholder Importance to Coffee

Smallholders are estimated to supply 80% of the world's coffee (Tucker et al., 2010; Vellema et al., 2015), and it is commonly cited that there are 20-25 million smallholder coffee farmers around the world (FEWSNET, 2013; Gresser & Tickell, 2002; Karanja & Nyoro, 2002; Luong & Tauer, 2006; Potts et al., 2014). While attempts were made to find the original source of the claim that 80% of coffee is produced by smallholders, no discrete study, data, or analysis was found to produce this. A statement made by Flood and Day (2016) that "up to 80% of global commodity production comes from smallholdings of less than 0.5 ha," was presumably in reference to all global commodities, including coffee and cacao, though this statistic was uncited (p.1). Tucker et al. (2010), explained that, in Córdoba, Mexico "smallholders (farmers with landholdings between 2ha and 3ha) have traditionally represented over 80% of coffee farmers, although rarely contributing more than 30% of the country's coffee harvest." Nyoro and Sprey (1986a) report, from a 1983 survey that covered 90% of all coffee production regions in Kenya, that 75% of the total land area under coffee production, and 60% of the country's production of coffee was attributable to smallholders. Potentially closer to being the original source is a 2012 commodity briefing by the Fair Trade Foundation, which says "25 million smallholders produce 80% of the world's coffee both in its introductory list of "fast facts," and in its conclusion statement (Fair Trade, 2012). The report does give specific breakdowns of the amount of coffee, and contribution of coffee to GDP of many of the world's coffee producing countries but cites the International Coffee Organization's (ICO) FAQ section for these claims. Upon a search of the ICO FAQ site in September of 2019, none of these statistics, nor the data or analyses behind them, were easily found. It is

therefore concluded here that one of these additions to the literature are a likely original source of the widely cited claim, though they do substantiate the perceived importance of smallholder farming to global food and coffee production.

Similar to the above question, the number of smallholders in coffee has been brought to public debate (Browning, 2018). The same effort was made as described above to find the original source of information for this review, but was unfruitful. Browning (2018), who also described following the claim of there being 25 million coffee farmers to a dead end, attempted to tackle the issue with an updated (or actual) analysis. Browning's study purposefully disregarded the fact that there are often multiple individuals contributing to coffee production on each farm (smallholder systems are at least partially characterized by family labor) and used "complicated statistics and analysis" to derive that there are roughly 12.5 million individual coffee farms on Earth. As there are likely multiple farmers associated with each farm tallied, the estimate of 25 million coffee farmers was neither refuted nor substantiated by Browning's study. It is, however, accepted within the industry that smallholders are both 1) enormously important contributors to the volume of coffee produced each year (thus a force worthy of specialized attention, support, and management), and 2) a population that is directly affected by production levels and pricing and numbering in the tens of millions. Tucker et al. (2010) report that over 4 million people in Central America and Mexico alone depend directly on coffee production and that the full supply chain (production, processing and purchasing) employs 8.5 million people. However, exact numbers are not necessary to confirm the importance of the smallholder farmer to global coffee production, nor the importance and implications of coffee for livelihoods. Given the vital relationship with smallholders, the

industry has a vested interest in ensuring the wellbeing of its small farming systems (Ponte, 2002).

Smallholder Perceptions and Decision-Making

Perceptions held by farmers greatly influence development mechanisms, such as adaptation and the diffusion of technological innovation, associated with increased farm viability and resiliency (Bathfield et al., 2016; Bielecki & Wingenbach, 2014; Tucker et al., 2010). It has even been said that something as impactful as climate change itself is not as strong of an obstacle to future prosperity as a society's ability and willingness to respond to changes, which are shaped by perception and knowledge (Röling & Wagemakers, 1998). Thus, to facilitate successful interactions, it is important for development agents to recognize that the reasoning of those they aim to help may be very different from that which is expected and, further, to identify any universal factors affecting the decision-adaptation process.

Due to their marginalization, smallholder farmers often do not respond to stressors or opportunities in the way one with ample resources might expect (Banerjee, Banerjee, & Duflo, 2011). Smallholders in developing and conflict-affected regions have little-to-no access to many of today's modern resources and must therefore make decisions based on cultural and social perceptions instead of calling on objective reasoning or scientific data (J. C. Scott, 1977). Lack of beneficial long-term decision-making often results in cyclical losses, called "poverty traps" that perpetuate the degradation of already limited resources, heavily undermining stability in marginalized populations (Bielecki, 2015; Pingali, Alinovi, & Sutton, 2005, p. S14; Sen, 2003). It is notably difficult for poor and low-income farmers to make beneficial long-term decisions, which often involve the trade-off of

lowered immediate gain, because of the ever-present need to support families (Donovan & Poole, 2014; J. C. Scott, 1977). Decision-making becomes even more challenging for smallholders under changing climate conditions (Barnett & Adger, 2007), and is directly affected by uncertainty (Ihli, Maart-Noelck, & Musshoff, 2014). As an example, contrary to what they anticipated, Tucker et al. (2010) found that coffee farmers in Mexico, Honduras, and Guatemala who perceived more risk from weather shocks and unstable pricing were *less* likely to have made adaptive changes in their production strategy. The study published in 2010 by Tucker et al. used open-ended questions to survey smallholder coffee farming households in the regions of Atitlán, Guatemala, La Campa, Honduras and Veracruz, Mexico with the purpose of assessing perceptions of risk and, at the same time, noting adaptive changes to livelihood activities such as investments in their coffee parcels, introduction of other crops, and migration away from the area. Risk was defined as "the probability or likelihood that an event will cause harm" (p.26). Respondents reported being concerned about perceived impacts of low coffee prices, illness of a family member, pest infestations, and extreme weather events (naming lack of rain more than any other climate event), in that order. The paper does not describe all predominant adaptation strategies, though it does explain that land-use change was highest in Honduras (nearly 75% had expanded land-area under coffee and/or legume production), while just 1% of respondents in Mexico and Guatemala had increased land area under production. A proposed reason for this discrepancy was the tendency of the Honduran farmers to have larger plots and fallow land, while the Mexican and Guatemalan farmers had smaller plots and nothing in fallow. What the authors found most notable, and what pertains most to the present study, was that farmers who mentioned weather events and/or low coffee prices as important concerns also

reported less adaptive action against these perceived issues. In fact, 80% of those who did *not* make an adaptive change to their practices still reported concern about low prices; Guatemalan and Mexican respondents in this category were less likely to have made adaptations than Honduran respondents, which the study suggests is due to the larger land area operated by the Honduran farmers. With these results, the hypothesis that farmers who perceive greater risk also take adaptive action against these risks, was unsubstantiated, surprising the authors. Conversely, Bielecki (2015) reported that perceptions held by smallholder coffee farmers in the Guatemalan Highlands did have great influence on the decision-making that led to chosen adaptation strategies and recommended that "future research further explore perceptions of crop diversification, coffee production, and the CLR" (p. iii). Logic follows that a person's perceptions about an issue shape their response to it. That said, just because someone has awareness of an issue does not mean they know the best course of action against it, have the resources to take action, or have the confidence that the action they take (which, in the case of adaptation to climate and environmental stressors, can involve high-level resource investment) will be an effective response. These are all important aspects of the development intervention context that should be brought to mind when designing and carrying out such projects.

Farmer Perceptions of Coffee Hybrids

To the best of our knowledge, the only example of an attempt to evaluate perceptions around the use of hybrids against CLR, on larger sized farms and for smallholders in the fight against CLR and other coffee diseases, was prior to the introduction of the dwarf hybrid 'Ruiru 11' to Kenyan smallholders in 1986 (Nyoro & Sprey, 1986a, 1986b). 'Ruiru 11' is an Arabica-Robusta hybrid which was bred for

resistance to CLR and coffee berry disease (*Colletotrichum kahawae*) (Gichimu, Gichuru, Mamati, & Nyende, 2013), and disseminated by the Kenyan government in 1985 and 1986 (Nyoro & Sprey, 1986a, 1986b). In 1984 and 1985, building on a 1983 survey, Nyoro and Sprey carried out surveys with a representative sample of Kenyan coffee estate managers and a stratified random sample of 280 smallholder producers, representing more than 90% of coffee producing regions in the country. Smallholders were defined as having 4 ha of land or less, with about 55% of the sample having 1.6 ha or less, and the estate farmers having over 8 ha, the largest of which had 140 ha. Both estate managers and smallholders were excited about the claimed characteristics of disease resistance, but preferred to trial the 'Ruiru 11' hybrids on a small plot of land before using them to replace existing plantations. Estate managers indicated an ideal trial/observation period of 5-6 years, and the smallholders 4-5 years. An interesting difference between the estate managers and smallholders was that 80% of the estate managers said their willingness to replace existing varieties with the hybrids would depend on their ability to clearly see that the hybrids had higher production in relation to their current varieties, while smallholders indicated they would renovate with 'Ruiru 11' even if it proved to produce less than their current varieties. This may be due to the fact that smallholders perform their own field management, which in the case of fungicides requires being in close proximity to the tree and spraying all surfaces of each individual plant using a backpack sprayer. Farmers who must take on these tasks themselves may be incentivized by not having to be in such prolonged and close contact with chemical sprays. It may also be that the farmers are acutely aware of the fungicide sprays as an additional cost, made necessary due to a recent influx of fungal disease and the need for these products, and more tied to their cost-income

balance for basic livelihood needs like food security. Or, it may be due to a loyalty they feel to whichever agency is promoting the hybrids, where low-educated and low-resource farmers are more reliant on a single source of information, which in this case had likely emphasized that the hybrids would reduce the need for chemical inputs. All of these hypothesized reasons for less emphasis on hybrid productivity are more likely prevalent in the smallholder mentality than that of the estate manager, for reasons previously stated in this chapter. Also of interest was that smallholders reported not applying fungicides or fertilizers to their existing coffee plantations at the rate or frequency recommended by the country's research foundation, though they did not express a perception that these recommended applications would be ineffective at treating disease.

Coffee in Guatemala

More than 4 million people in Mexico and Central America are directly dependent on coffee production and it is especially important to the livelihoods of indigenous communities in these regions (Baca et al., 2014; Fischer & Victor, 2014). Guatemala is the second largest coffee producing country in Central America, ranked 10th in global production (Szenthe, 2019). Coffee is grown in 204 of 334 municipalities, covering significant land area (Anzueto, 2013). Ninety-five percent of Guatemalan coffee is produced from the Arabica species; the remaining 5% is harvested from the Robusta species (Tay, 2016, 2019). The country's coffee industry supplies its most important export, contributes significantly to GDP, and provides 150,000 year-round and 300,000 seasonal jobs, mainly in rural areas where poverty and malnutrition are highest (Fischer & Victor, 2014; Tay, 2016).

Guatemala is also a country heavily affected by CLR and home to thousands of smallholder producers who are dependent on coffee for their livelihoods (Fischer & Victor, 2014; Tay, 2016). Pons, Taylor, Griffin, Castellanos, and Anchukaitis (2017) describe it as one of the world's countries most vulnerable to climate change due to the population's dependence on rain-fed agriculture.

The Case: Sustainable Incomes through Coffee Farming Improvement Project – San Pedro Yepocapa, Guatemala

The coffee hybrid, 'Centroamericano,' which has been publicly available for purchase at a handful of large commercial nurseries in Central America since 2010, is marketed as a coffee variety that shows resistance to CLR, generates high yields, and possesses good cup quality[12]. Because of these beneficial characteristics, 'Centroamericano' plantlets were distributed by the *Sustainable Incomes through Coffee Farming Improvement* (SICFI) project to six associations of smallholder farmers to help them upgrade from outdated and rust-susceptible coffee varieties and ultimately overcome CLR devastation.

The target population lives in the Yepocapa region, which covers 217 km^2 of land, spanning 800 to 1800 masl in southeastern Guatemala, about a 60-min drive from Antigua and just 7 km (~ 4 miles) northwest of the active crater of the Fuego Volcano, in the District of Chimaltenango, in the Guatemalan Highlands (Figure 6, Figure 7, and Figure 8). The full name of the region is "San Pedro Yepocapa," but most refer to it as "Yepocapa,"

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[12] More information about cup quality of varieties available at these two sources:
https://dailycoffeenews.com/2017/05/24/new-rust-resistant-hybrid-centroamericano-scores-90-at-nicaragua-coe/
https://sprudge.com/have-scientists-found-a-climate-change-proof-coffee-variety-143076.html

or simply “Yepo.” There is also a town called San Pedro Yepocapa located in the region of the same name. The present study will use the name “Yepocapa” in reference to the region as a whole, and “San Pedro Yepocapa” in reference to the town. Yepocapa, the region, was identified by Anacafé as one of the two regions most affected by the CLR epidemic of 2012-2013.

Through a project funded by The Starbucks Foundation, World Coffee Research (WCR) partnered with Anacafé to disseminate a rust-resistant coffee hybrid called ‘Centroamericano’ to the members of six smallholder Yepocapa coffee farming associations with the intent of helping them overcome the damage of CLR and regain healthy, robust livelihoods (Table 1). Yepocapa was selected for the project due to the devastating impact of CLR and because coffee production is the main source of income for hundreds of smallholder farmers who reside, raise their families, and produce coffee there. The SICFI project hypothesized that the incomes and livelihoods of the farmers would be greatly improved by switching from outdated, rust resistant coffee varieties to new, improved varieties, thus helping them overcome devastating socioeconomic impacts of CLR. The project further anticipated that the hybrid technology would become disseminated throughout the communities, as successes were witnessed by those who did not receive the plants originally, who would then seek to implement ‘Centroamericano’ within their coffee parcels as well. The predicted mechanism for this dispersal was that farmers who liked the hybrids and did see higher income as a result of their implementation would tell their neighbors, friends and family members, who would in turn be interested in implementing ‘Centroamericano’ in their own farming systems.

Figure 6. The town of San Pedro Yepocapa, with a cloud of vapor and ash from the nearby Fuego Volcano in the air.

Table 1. Number of members, age, location and distance from the town of San Pedro Yepocapa of the six associations involved in the SICFI project, as per August 2017.

Cooperative	# of Members	Age	Location	Travel Time to San Pedro Yepocapa by Car
ECA Montellano	187	27	Hermogenes Montellano	40 min
Assoc. Maya Kiché	30	17	Hermogenes Montellano	40 min
Coop. San Pedrana	44	50	San Pedro Yepocapa	0
Assoc. Chuachilil	79	30	San Pedro Yepocapa	0
COFEAG	50	4	San Lucas Miramar	75 min
ECA Chuachilil	23	31	San Pedro Yepocapa	0

Figure 7. Picture taken from the salon of the ECA Montellano Cooperative, showing the town of Hermogenes Montellano. The Fuego Volcano erupts in the background.

Figure 8. The Yepocapa region. Coffee plants bloom in the foreground.

Between June 30 and August 9, 2016, 179 farmers from the six organizations received a total of over 130,000 plantlets of the newly bred, asexually propagated coffee hybrid, 'Centroamericano,' along with 250 46-kilogram bags of an NPK "multiplex" fertilizer. Three local agronomists were hired to provide technical assistance to the farmers and collect biophysical, social, and economic data from the farmers, parcels and plants. It was originally intended that 339 farmer families would receive the new plants; however, the final number of recipients was 179, approximately half of the original target. Although a few of the originally named farmers did not have land available by the time the plants were delivered, the reason for this is large reduction in participants remains unknown[13]. Given the established relationship with the farmers and the introduction of the 'Centroamericano' coffee hybrid, there was a unique opportunity to follow the decision-making processes in this population and thereby gain valuable insight to strengthen positive impacts of future development.

[13] While this inconsistency must have root cause, it is important to note again that adoption was not studied as part of the present research, and thus this statement is provided simply as background and grounds to ask the question: what has affected the Yepocapa farmers' *intent* to adopt the hybrid.

CHAPTER III

METHODS

Case Study Approach

Introduction

This research was qualitative in nature, calling on instrumental, multisite case study methods to evaluate phenomena affecting the outcome of a development intervention through comparative analysis and comparison of thick, rich, descriptive data to a well-documented theory of human decision-making (Merriam, 2009; Weiss, 1998; Yin, 1992). Evaluation is a type of research that is carried out in a real-life setting, often in assessment of an intervention (Yin, 1992). The case study is specifically characterized by the entity (or entities) to which it is bounded, which is (or are) selected due to being "an instance of some process, issue or concern" (Merriam, 2009, p. 41). A multisite case study encompasses two or more distinct cases that "share a common characteristic or condition," which are treated as subunits within the bounded system, and the instrumental element offers insight which is generalizable to a greater context (Merriam, 2009, p. 49). The bounded context of this study was the members of six associations of smallholder coffee producers located in the region of San Pedro Yepocapa, Chimaltenango, Guatemala, each of which has its own unique structure, history, and membership, and all of which exist to facilitate the production, processing, and sale of coffee grown by its members.

Methodology

Case Study as Compared to Ethnography and Grounded Theory

Ethnography and grounded theory are distinct forms of inquiry that have similarities to the case study because they investigate real-life situations and rely on direct engagement of the investigator with the context and phenomena of study to frame their direction and analysis (Yin, 1992). All three methodologies also call on the investigator as the primary instrument of data collection (Merriam, 2009; Weiss, 1998; Yin, 1992). As such, all require self-reflection on the part of the investigator to identify and separate personal biases throughout study design, implementation and analysis (Merriam, 2009; Weiss, 1998). Due to resemblances between these three methodologies, it can be confusing for a researcher to know if and when to apply each, and for the external reader to be clear on which was used. For clarity in the present study some of the more salient distinctions are described here, provided by Yin (1992), with support from other authors where noted.

Case Study: The case study method offers a holistic approach by which the researcher can "keep focus on the totality," through investigating multiple points of view and analyzing multiple forms of evidence (Berg, 2001; Merriam, 2009; Weiss, 1998, p. 261). The case study is not a form of data collection, but a methodology that can call upon a wide range of data gathering mechanisms depending on the case, including, but not limited to, individual and group interviews, document and artifact inspection, and observation (Berg, 2001). The focus of a case can be as narrow as one person or event, or as broad as an entire society, characterized mainly by rich, detailed information that seeks to produce in-depth understanding (Berg, 2001). The case is "bounded" by the entity (or entities), timeframe, location and phenomena selected (Merriam, 2009). In essence, the

case study tells a story, and if written well, is particularly powerful at articulating facts that might otherwise be lost if presented in nondescript narrative. Case studies are useful in research, evaluation, and exploratory inquiry, incorporating context with data collection to facilitate holistic assessment of both real-world interventions and their process of implementation (Berg, 2001; Yin, 1992). Because of their structured, though holistic approach, case studies should be considered in every sense as valid, empirical research and are well-suited to evaluation of program and process (Yin, 1992). To be most successful, case studies should compare the bounded phenomena to a previously developed theory, though they can also (simultaneously or not) produce new theory (Geddes, 2003; Yin, 1992).

Ethnography: Ethnographic study centers on the idea that multiple realities exist, even around just one event, theme or concept, all of which are valid and exist simultaneously (Weiss, 1998; Yin, 1992). To properly represent these multiple realities, this methodology places the investigator directly within the studied context such that they experience the phenomena themselves, instead of maintaining objectivity through distance (Yin, 1992). This methodology decidedly does not place theory at the start of an investigation, instead, theory is constructed by the investigator, generating from their own experience while submerged in the phenomena and strengthened by full immersion and prolonged engagement (Weiss, 1998; Yin, 1992). As such, ethnography does not follow the norms of traditional empirical scientific inquiry, "which assumes a single objective reality that can also be repeatedly replicated" (Yin, 1992, p. 125).

Grounded theory: The purpose and strength of grounded theory is to allow the emergence of novel theory during the investigation – the roots, framework, and substance

of which are “grounded” in the phenomena studied (Creswell, 2009; Merriam, 2009; Yin, 1992). It is advised that grounded theory not initiate with detailed hypotheses or firm boundaries at the outset, as true employment of the method requires that these emerge throughout the process of exploration and observation (Yin, 1992). A general purpose statement such as, “how does [a specified subset of a population] make decisions regarding [X] when under a unique type of duress” help identify the central phenomena, participants and site (Creswell, 2009; Strauss & Corbin, 1990). However, further detailing of the research question contradicts the purpose of using grounded theory, which is to let the phenomena itself dictate its own bounds, direction and final analysis (Yin, 1992). Due to the grounded, emergent nature of this methodology, a researcher can end with a different scope of study than what they set out with (Heath & Cowley, 2004).

The qualitative nature of all three methods relies heavily on the primary researcher as the instrument by which data is collected, however these methods are not interchangeable, nor should they be utilized in the same contexts or for the same purposes. Each produces results of varying forms and empirical significance, and should be clearly delineated in the mind of the researcher and reader (Yin, 1992). It is inherent to both ethnography and grounded theory that a study drive its own direction, requiring lack of detailed scope and precluded expectation of the final outcome(s) on the part of the investigator (Heath & Cowley, 2004). The information passes through their lens, but if they don’t remain flexible to changes in direction or unforeseen outcomes, they are not adhering to the essence of the method.

While the case study should initiate with theory or hypothesis, this is not advised in ethnographic evaluation or grounded theory. The case study method is highly suited to

evaluation because it permits (and often emphasizes) the use of a "yard stick" to measure outcomes against (Weiss, 1998). Only by comparison to a standard can anything be truly evaluated, whether it's a day-to-day encounter (e.g. "the coffee served this morning is better than the coffee served yesterday"), or a programmatic intervention (Weiss, 1998). For this reason, ethnographic study and grounded theory may not be appropriate methods for an evaluative research and were not utilized in the present study.

In this multi-site case study, the Rogers' model of the five stages of the innovation-decision process provided the existing theory by which to compare and contrast findings, and the SICFI project provided the bounded phenomena of study. Initial analysis was carried out by a local research team, which produced thick, rich, group-level data, and was further sustained by the principal investigator using the constant comparative method to identify themes common to all groups. These themes are presented in Chapter 4, and their comparison to the Rogers' model is presented in Chapter 5. The remainder of this chapter describes the methodology employed to collect comprehensive data directly from the Yepocapa farmers on their obstacles to production and sale of coffee, perceptions of the 'Centroamericano' hybrids, and interactions with the project that introduced them. It was imperative to the value of this research that all information originate directly from the farmers and as accurately as possible reflect their true perspectives on the themes discussed. To best achieve this, emphasis was placed on developing trusting relationships through extended engagement with the principal investigator who lived in Guatemala for nearly two years, working through local channels whenever possible, spending ample time on introductions and during the consenting process, and the use of participatory methods and open-ended questions. These efforts are described here. The chapter ends with a

description of methods employed in data analysis, and to establish credibility, consistency, and transferability of results.

Participatory Methods

It is intended that the findings of this evaluative case study will inform future development projects aimed at building capacity in smallholder coffee farming communities, including the very communities in which this research was performed. Success in bringing about beneficial, long-term changes through development intervention is most likely to occur when community members take a significant role in the evaluation of their own situation (Douthwaite, Beaulieu, Lundy, & Peters, 2009; Narayanasamy, 2009; Toness, 2001; World Bank, 1996). Due to the intention to support capacity building efforts, and the potential for the very act of discussion to help subjects better understand their own situation and develop solutions to any constraints they identify (Chambers, 1992; Krueger, Casey, Donner, Kirsch, & Maack, 2001), high-level farmer participation was considered especially important and was a central theme in developing the methods employed.

Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) is defined as "a family of approaches and methods to enable rural people to share, enhance, and analyze their knowledge of life and conditions, to plan and to act" (Chambers, 1992). While there are multiple participatory approaches to research (Toness, 2001), participatory rural appraisal is a data collection method that specifically aims "to enable local people to share, enhance, and analyze their knowledge of life and conditions, to plan, act, monitor and evaluate" (Narayanasamy, 2009, p. 26), with the ultimate goal of building local capacity (Chambers, 1992;

Douthwaite et al., 2009; Toness, 2001). The historical basis of this "family of approaches" was a paradigm shift in research and development that occurred through the 1980s and 1990s, built on concepts solidified through previously existing data collection methods, namely, activist participatory research (APR), agroecosystem analysis, applied anthropology, field research on farming systems, and rapid rural appraisal (RRA) (Chambers, 1992, 1994).

RRA, which can be thought of in evolutionary terms as the most recent ancestor of PRA, sought to eliminate biases that came from researchers making short visits to the region of study, the use of long and tedious questionnaires, and inefficient use of funds in data collection efforts that conformed to the heavily quantitative standards at the time instead of being more tailorable to the study context (Chambers, 1992). Quick, abrupt, "in-and-out" visits to research sites resulted in investigators missing important information like seasonal fluctuations, and phenomena and sites that took longer to physically reach, while also generating the need to meet with an ideal group of subjects who could quickly respond to written questionnaires, and often electing not to meet with poorer or more marginalized members of the population(s) who may not have the ability to swiftly provide response or fill in answers to written, quantifiable surveys (Chambers, 1992). RRA called upon the use of exercises like mapping, diagramming, and ranking, which were carried out cooperatively between researchers and subjects and employed locally familiar symbolism instead of exclusively relying on worded description, allowing comprehension of a wider range of subjects, including those who were illiterate (Cavestro, 2003). Robert Chambers, who has written extensively on PRA since the early 1990s, described a continuum between RRA and PRA, where RRA involves outsiders learning directly from locals and extracting

that knowledge to fulfill their study objectives, and PRA calls on outsiders as catalytic facilitators who help empower locals to identify and analyze their own circumstances, often in such a way that they themselves can develop solutions to their own deduced needs Chambers (1992).

Participatory methods have been utilized extensively by agencies such as the Consultative Group on International Agriculture (CGIAR), in the United States, Africa, and Asia, supported by funding from such entities as USAID and the World Bank (Chambers, 1992; Narayanasamy, 2009), and have served prominently in investigations of phenomena affecting smallholder coffee farmers (Bacon, Mendez, & Brown, 2005; Bacon et al., 2017; Barrios & Trejo, 2003; Bathfield et al., 2016; Bielecki, 2015; Blundo Canto et al., 2015; Montgomery, 2019).

Research Team

In most qualitative research, the researcher is the primary instrument through which data is collected (Merriam, 2009). The research team consisted of Texas A&M doctoral student in Horticultural Sciences, Taya Brown, as principal investigator, a Guatemalan study coordinator, and three local agronomists knowledgeable in coffee production, the local communities, and implementation of 'Centroamericano' coffee hybrids. In this case, the instrument's scope was amplified by the participation of the four Guatemalans, one a research specialist and the other three from the local region. Including locals in the research is important to the accuracy and usefulness of study results (Merriam, 2009) and is a principle tenet of PRA methods (Narayanasamy, 2009). Wording and clarity of questions is essential to garnering responses that address the desired information (Berg, 2001; Merriam, 2009) and it is highly recommended that all focus group activities be

carried out in the native language of participants (Krueger et al., 2001). Thus, the involvement of locals with background knowledge on the topic of discussion is crucial for collecting accurate and useful data from a rural, ethnic subject population (Krueger & Casey, 2014; Toness, 2001).

Daniel Dubón, study coordinator, is a Guatemalan agricultural GIS and data management expert contracted by WCR to coordinate the SICFI project and other in-country activities. He was serving in this role at the time of method development and data collection and was therefore familiar with the Guatemalan coffee industry, the Yepocapa region and its farming communities, the other three members of the research team, and the administrators of the SICFI project. This local knowledge and familiarity were called upon extensively throughout the study. During research design phases, Dubón assisted in considerations of feasibility, logistics, cultural acceptability, focus group exercise and question development, subject selection, data collection, and initial data analysis. He will be referred to as "study coordinator" for the remainder of this document.

Juan Charuc, Wilson Ordoñez, and Mario Turcios were employed to assist the SICFI project in carrying out and monitoring field activities at the time of data collection. In their role as part of the SICFI project each was responsible for regularly interacting with the leaders and members of two of the associations, visits to the farms where the plantlets were being cultivated, and biophysical data collection (e.g. plant measurements) from the coffee parcels. As this role required them to be in direct contact with the farmers and leaders in each community, they were an ideal team to employ in the present study. All three worked closely with the principal investigator and study coordinator to identify subjects with designated characteristics and it was through them that selected farmers were

notified of and invited to attend the focus group meetings. These three individuals, referred to in English as "project personnel" or "project monitors," are called *Promotores* (*Promotor* is the singular version) in Spanish and will be referred to as such for the remainder of this document.

All members of the research team were certified in human subject research by the Internal Review Board (IRB) at Texas A&M University. The principal investigator and study coordinator were certified through Collaborative Institutional Training Initiative (CITI) training available online. The *Promotores* were field-trained in human subject research by the principal investigator and study coordinator using a PowerPoint presentation developed from CITI materials and reviewed by the TAMU IRB prior to implementation (IRB2017-0257D).

Having local representation in the research team was crucial to successfully carrying out this study. Partnership with the study coordinator, a researcher native to the language and national culture of the farmers, and the *Promotores* as agronomists local to the region, reduced the potential for misperceptions to arise between the researcher and subjects and was important in helping the primary researcher and future readers of the study more accurately and holistically view the data (Lincoln & Gonzalez y Gonzalez, 2008). These team members coordinated logistics, made introductions, attended to subjects throughout the focus groups, provided structured observation, and assisted the principal investigator and study coordinator during initial stages of data analysis. During meetings with the subjects, the local faction of the research team provided familiar faces and helped describe the exercises and their intended importance to the subjects in a localized and comprehensible way that would have been impossible for an outsider from another

country, or even another region, to achieve (the study coordinator is from North Central Guatemala, is formally educated to the Master's level, and was living in Guatemala City at the time of the study). The *Promotores'* understanding of the local context, including both Spanish and indigenous words unfamiliar to the principal investigator and in some cases even to the study coordinator (e.g., terms specific to coffee morphology, localized pests, seasonal changes, coffee production and sale, agricultural tools and chemical products, measurements and conversions) helped bridge what would have otherwise been large gaps in knowledge and understanding. All members of the Guatemalan research team were consulted throughout development of the data collection exercises carried out within the Yepocapa communities and were actively employed in the design and execution of the following activities (Krueger et al., 2001).

Focus groups

Obstacles to production and sale of coffee were identified by the subjects themselves through focus groups (FG) held with each of the six farming associations involved in the SICFI project. FGs are commonly used in participatory and case study research (Nyumba, Wilson, Derrick, & Mukherjee, 2018), defined as "an interview style designed for small groups," who are led through discussion on a particular topic by a moderator (Berg, 2001, p. 111), with the goal "to obtain perceptions on a defined area of interest in a permissive, non-threatening environment" (Krueger & Casey, 2014, p. 5).

FGs were first developed as a data collection technique in the 1930s and 1940s by marketing departments who wanted a better understanding of consumer perceptions around a product so they could better advertise its qualities to the public (Chalofsky, 1999). Rich description coming directly from discussion amongst participants helped marketers

understand the perceptions and experiences their customers had with the products and build campaigns around this information, highlighting benefits and addressing any pitfalls. An example given by Chalofsky (1999) is boxed cake mixes, which were developed such that all that was required for preparation was the addition of water to a dry mix. FG participants shared that they liked to feel (and tell others) that they had made the cake from scratch, and that they did not feel like this was true when the only contribution needed from them was the addition of water. This information led to a redesign of the boxed cake product such that eggs, oil *and* water were required additions. With this new design, FG data showed that participants felt sufficiently involved in the baking process with the altered product format and would be content purchasing and preparing the redesigned boxed cake mixes.

In research application, the FG is a group interview supported by a moderator that purposefully calls on participants' natural interactions with each other, analyzed in a way that combines perspectives, with the goal to paint a picture or tell a story that is representative of the collective experience of the community or population participating (Grudens-Schuck, Allen, & Larson, 2004). FGs are dynamic and provide the space for synergistic conversation amongst participants, allowing them to build on and react to each other's comments and giving the researcher an opportunity to observe these interactions (Berg, 2001). According to Berg (2001) this technique is especially useful in qualitative research because, while individual interviews "permit a more detailed pursuit of content… a far larger number of ideas, issues, topics, and even solutions to a problem can be generated through group discussion" (pp. 112,115). FGs are especially useful in designing a line of questioning that uses appropriate topics and wording where there is a language,

cultural, or regional gap between the researcher and subjects, or when the researcher is otherwise unfamiliar with the subjects or phenomena of study (Morgan, 1993, p. 16; Narayanasamy, 2009). FGs also "allow the participants to feel a sense of ownership around the issue on the table" (Chalofsky, 1999, p. 1), and produce insight in ways that other forms of data, specifically surveys and quantitative data collection, do not (Grudens-Schuck et al., 2004; Larson, Grudens-Schuck, & Allen, 2004). Thus, a combination of FG interviews, artifacts produced by participants, and observations effectively circumvented issues that may have otherwise arisen due to cultural differences and language barrier between the primary researcher and the subjects, and produced a well-rounded data set.

Focus Group Pilot

A pilot of the focus group exercises was implemented on August 16, 2017 with 14 members of a smallholder coffee farming association in San Miguel Escobar, Sacatepéquez, Guatemala. San Miguel Escobar is about an hour's drive from San Pedro Yepocapa, though less than 10 miles (16 kilometers) as the crow flies, and at a similar elevation range, with farmers that operate similarly sized farms. The purpose of the pilot was to test the exercises, identify any cumbersome or hard to understand aspects of the questions asked of subjects, and calibrate the research team to making observations. The pilot was highly successful and did indeed contribute to successful implementation, and uniformity, of the exercises when carried out with the target population. One outcome of the pilot was that the study coordinator, as moderator, learned that he should proactively move the conversation forward at times, not enough to change the direction, but enough to keep each theme from taking so much time that the team and subjects would become exhausted and unable to interact in a useful way.

Yepocapa Focus Groups

Two focus groups were implemented per association, one including a representative sample of the association's general membership (FG1) and one including only the Board of Directors of the association (FG2). Both FG for each association occurred on the same day but at different times, at the centralized meeting location of that association. A total of 12 FGs were held, including 107 participants across the six associations (Table 2).

The protocol described below was sanctioned by the Texas A&M University IRB, under identification number IRB2017-0257D.

Table 2. Number of farmers included in the focus groups.

Cooperative	Cooperative Members	Board of Directors	Total
ECA Montellano	16	10	26
Assoc. Maya Kiché	11	2	13
San Pedrana	15	4	19
Assoc. Chuachilil	14	2	18
COFEAG	12	4	16
ECA Chuachilil	14	3	17
Total	**82**	**25**	**107**

PRA Exercises

A wide array of data collection methods is utilized in PRA, designed to gather data while heavily involving the subjects in rich description of the targeted information. The following are exercises described by Narayanasamy in his 2009 book, *Participatory Rural Appraisal: Principles, Methods and Application*, modified with assistance from the local

research team, and input from experts at Anacafé, to fit the cultural context of the Guatemalan Highlands, Yepocapa, and smallholder coffee farming.

The purpose of the focus group exercises was to gain a comprehensive understanding of the history, current state of affairs and access to resources, as perceived by the farmers of each coffee farming association in the project. To achieve these objectives, four main forms of data were collected: 1) a timeline of development and issues in coffee as experienced by each association, 2) a mobility map showing the locations regularly traveled to by association members throughout the year, 3) subject responses to 13 open-ended questions covering themes of interest (Appendix A) (Narayanasamy, 2009), and 4) observations made by the research team throughout these exercises. The timeline and mobility map resulted in diagrams depicting spatial and temporal information and also provided benefit as icebreakers to assist in developing a rapport between subjects and the research team that resulted in fluid conversation and candid responses (Berg, 2001; Narayanasamy, 2009). For a more detailed description of the FG procedures see Appendix B.

Mobility Map Purpose and Target information

As is highly recommended for most interviews, FG discussions began in a casual manner, first building rapport, and then progressing from unobtrusive topics towards more sensitive subjects (Krueger & Casey, 2014). Through documenting patterns of movement and distances between regularly attended locations a mobility map provides information about the resources available to a community, including modes of transportation and frequency and ease in accessing resources, thus also highlighting any obstacles regularly experienced in covering the distances between important sites (Narayanasamy, 2009). The

mobility map is a relatively simple exercise used to begin engaging subjects and initiate the conversation about their experiences in coffee production while requiring each participant to interact directly with the research team. It also provided "a sort of checklist for facilitating the timeline exercise" that took place immediately after creation of the mobility map (Narayanasamy, 2009, p. 152).

To begin the mobility map exercise, a large blank piece of paper was hung on the wall in front of the group with only the central meeting location (the location of the FGs, where each group was physically located during the meeting) noted on the page. Subjects were asked to describe the places they regularly travel to for reasons related to production or sale of their coffee, and to position these on the paper in relative location to one another. Once the towns and other major landmarks were in place on the page, each participant was given a sticky note with their name written on it as a representation of their coffee parcel(s), and asked to place these on the map where they would most accurately reflect positioning relative to the other locations depicted (Figure 9). Sources of water, holdings such as land managed by the association, and anything else the subjects suggested as important to coffee production and sale were also added. By the end of the exercise, a map was created showing the community in perceived relative distance to all locations regularly traveled to, noting the mode of transportation normally used and time it takes to get there (Figure 10).

Figure 9. ECA Chuachilil members work together to place their parcels on a mobility map showing the locations and resources in the area which are important to their coffee production.

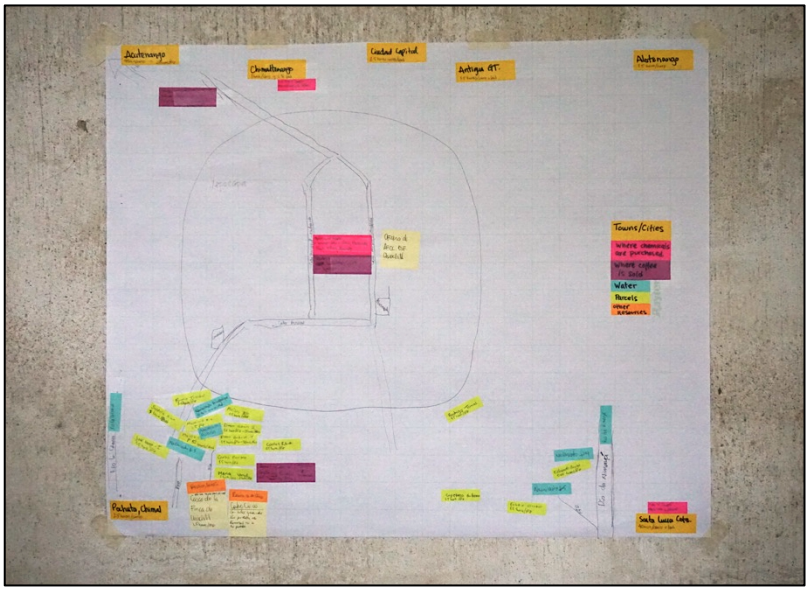

Figure 10. A mobility map created by the members of the Asociación Chuachilil showing the important resources in the region and association members' coffee parcels, along with the travel time and mode of travel between locations.

Timeline, Purpose, and Target Information

In his book on PRA, Narayanasamy (2009) described gaining an in-depth understanding of past and present context through the creation of a timeline as a "biography tracing the life of a particular phenomenon" (p. 144). In this case, the timeline depicted significant historical experiences with coffee diseases, drought, climate changes, and weather shocks as well as significant technological, social, economic, or structural changes in the associations having effect on the abilities of the communities to produce and sell coffee.

Timeline construction began with a horizontal line drawn on a long sheet of butcher paper taped to the wall. Information given by the subjects was recorded along this line, starting from the time the association was formed and ending at present. Discussions began with the icebreaker question, "How did this association get its name?" (Narayanasamy, 2009). From there, subjects were asked to describe the development of the association from its establishment to the current state of affairs, including membership size and composition, what coffee varieties were commonly grown when, dates of past development and/or issues such as diseases affecting the coffee or technological advances in production, processing and/or marketing. Dates and events were recorded along the line drawn on the page, starting with the date the association was established and ending in the present. Special attention was paid to development interventions, innovation, CLR, pests and pathogens aside from CLR, coffee prices, coffee markets, weather shocks and climate conditions. The purpose was to discuss and record, from the farmers' perspective, 1) the sequence of events that led to the current state of coffee production and sale in the region,

2) any notable impacts of these events, and 3) coping and reactionary strategies used by the farmers in response to the events.

The research team followed subject responses with probing questions about experience, behavior, opinions, values, feelings, knowledge, and background to further investigate events introduced by subjects throughout creation of the timeline. Examples of probing questions used are: Can you tell me more about that? How did that work? What happened next? When this happened, what did you do? Is there anything else you would like to share in regard to this topic? (Berg, 2001, p. 76; Krueger & Casey, 2014; Merriam, 2009, p. 9; Owens & Ewers, 1990). The research team paid special attention to that which most likely has had, or will have, effect on production and marketing of coffee and perceptions of coffee hybrids. The last hour was spent in discussion with subjects, further investigating issues brought up in the timeline and mobility map exercises, and discussions around the 13 research questions.

Subject Selection and Recruitment

Site Selection

The six associations from the Yepocapa region were recruited by specialists at Anacafé as the target beneficiaries of the SICFI project based on two important characteristics, 1) being one of the two regions identified as most heavily and extensively impacted by the CLR epidemic of 2012-2013, and 2) due to being characterized by smallholder coffee farming, where families are highly dependent on coffee sales for their household income.

In research such as this, it would be ideal to interview every member of each association involved in the SICFI project to gain the most holistic understanding of the

events, perspectives, and impacts possible. These communities, however, total several hundred farming families and it is therefore not feasible to perform an in-depth interview with every individual. Since the goal of this work was to dig deep into regional history, perspectives, events and impacts, and at the same time cast a wide net to capture as much pertinent information as possible, a representative sample of farmers was selected to partake in the study.

Purposive, non-probability sampling was used to identify a representative sample of the members of each association, thus producing a group of members that is typical of that association (Merriam, 2009). Purposive sampling is used to "select a sample from which the most can be learned," which is particularly useful when evaluating the effect(s) of a program on a range of subjects and in selecting FG participants (Merriam, 2009, p. 77; Narayanasamy, 2009; Weiss, 1998). Probability, in terms of sampling, refers to every member of the subject population having the same probability of being selected as a study participant. Statistical generalizability is not the goal in qualitative research, therefore "probabilistic sampling is not necessary or even advisable" as a subject selection method in qualitative studies (Merriam, 2009, p. 77). In this case individual farmers were selected purposefully, due to having one or more of the characteristics sought by the research team, therefore some individuals had a high probability of being selected while others did not. Generalizability based on these methods is further explained at the end of this chapter. Selection criteria are described in the next sections.

Group 1: Members of the Associations

Several characteristics were considered when deciding how to select the farmers to be invited to participate in the FGs (Table 3) Literature provided direction for one level of selection, such as age and gender. The local research team was relied on heavily in determining a second set of selection parameters, which included such qualities as ethnic identity and length of experience in coffee production. The main objective in the selection of participants was to include farmers with a range of characteristics, to offer varied insight into the phenomena studied and allow for a holistic understanding of the farmers' perspective. Farmers were selected on the basis of having characteristics typical of the region, which were thought most likely to affect perceptions and decision-making regarding newly introduced coffee hybrids.

For general research purposes, FGs should include six to twelve participants (Chalofsky, 1999; Grudens-Schuck et al., 2004; Krueger & Casey, 2014). An in-depth review of FG methodology by Nyumba et al. (2018) reports a recommended number of ten participants per FG for research similar to the present study, explaining that more than twelve limits collective discussion – participants tend to break off into sub-groups and not contribute to the discussion as a whole, detracting from the group dynamic and leaving the researcher unable to capture all that is said.

Age is one characteristic which can greatly affect willingness to adopt new technologies (M. Morris & Venkatesh, 2000). In order to simplify sampling and keep group size low, a minimal number of age delineations were used in the selection process; thus, after the 18-32 age bracket, all older working-age brackets were combined. Having a representation of participants in each decade of life would have added a significant

number, causing groups to be large enough to reduce individual contribution and group discussion, and thus, reducing effectiveness of the FG method to produce accurate and holistic data[14]. Additionally, for the purpose of this study, analyses were not going to be based on age groupings, so it was more essential to the quality of the work that groups were kept within a manageable participant number.

Participant age was, however, a characteristic which required substantial attention, including discussions amongst the research team and protocol revisions. It is common in Guatemala for children under an official working age to carry out basic household and farm-level activities alongside their families (Schuit, 2012). On preliminary visits to the region, the principal investigator found that some of the children were well-versed in farming activities and interested in sharing their knowledge. On one particular instance, a boy of about 10 years essentially commandeered the direction of a farm visit, taking the hand of the principal investigator and enthusiastically demonstrating in-field details about coffee, bananas, mandarins, plantains and weedy species, and sharing a vast knowledge of each plant and phenomena. Such experiences indicated that the youth of Yepocapa had potential to be knowledgeable and helpful participants of the FGs. When considering their inclusion, however, it became apparent that this would add a level of complication that was best left untouched, for two main reasons. Reason one: As per IRB requirements, each participant under the age of 18 would have needed parental authorization in the form of a signed consent form. The local team thought it would be culturally awkward if parents

[14] Initial selections were attempted in this way, using statistical methods to process information about the association members known from a census-type survey done by the SICFI project. This attempt produced groups which would have included over 30 participants, which was inadvisable.

were asked to sign a document authorizing their son or daughter to be involved in a research study. They explained that, for many Yepocapa residents, the only time they use an official signature (or, for some, interact with paper and pen at all) is when they sign legal documents, which has a negative connotation. As there are varied levels of educational background and experience signing official documents amongst the Yepocapa farmers, some parents may have not had any issue with this, while others may have been confused or skeptical. Therefore, to pursue the intention of including participants under the age of 18 would have required separate meetings with parents of the potential under-age participants. Such meetings would have dedicated specific attention to description of the study and its objectives, and to explaining the consent form and reasons for its use. According to the research team, due to the varied backgrounds of the farmers, this effort would likely still have resulted in heterogeneous comprehension, while also risking heightened skepticism toward the researchers and the study. Reason two: At the time the study was being planned (2016-2017), there was a public outcry that child labor is commonplace in the coffee industry in Guatemala (Brown, 2016b). The uproar followed a 2016 Danwatch report that claimed the Guatemalan coffee industry was in violation of international conventions on child rights, child labor, forced labor, and the freedom to organize and unionize (Hansen & Thing, 2016). Anacafé responded to these claims in a public statement to Daily Coffee News, a US-based publication by Roast Magazine (Brown, 2016a) and in a public letter addressed to Danwatch administrators (Anacafé, 2016). Personal communication with the manager of several large coffee estates in Guatemala, and with members of the US coffee industry, indicated high tensions over this issue. There is no indication in Yepocapa that involvement of younger family members in

farm-level activities is harmful, in fact, rather the opposite – there is a pride when a family's descendants are well-versed in coffee production and this appears to correlate with an ambition to continue the family legacy in coffee production, something many development agencies have dedicated funding and effort toward (USAID, 2017). However, for the reasons just explained, it was decided by the research team that it was better not to investigate the level to which individuals under the age of 18 are involved in coffee management activities. Therefore, individuals under the age of 18 were not included in the FGs.

To define the term "youth" for the younger subgroup that would be invited to the study, the research team turned to two definitions, one from Guatemala and one from Africa. The Guatemalan National Youth Policy (Gobierno de Guatemala, 2012) defines "youth" as anyone aged between 13 and 30 years. Given that there were only two other age categories in the study (adult and elderly), and due to the exclusion of farmers under the age of 18, the research team wanted to give ample opportunity to invite younger farmers to the FG. The African Youth Charter defines youth as any person between the ages of 15 and 35 years (African Union Commission, 2006). The research team came to a consensus that the youngest age category should be a hybridization of these two definitions, concluding that age 32 should the cut off for "youth," and the adult group would start at age 33 for the present study.

Gender can also have effect on an individual's propensity to adopt agricultural innovations (Doss & Morris, 2000). Ragasa (2012) found that women consistently exhibited slower rates of adoption across 35 case studies focused on a range of technologies. Thus, though it is vastly less common for a woman to be the owner or

primary manager of a coffee parcel in the Yepocapa region, it was seen as essential to the quality of the study that some women were present for each focus group. In this region women do most of the housework, cooking and childcare, and do not participate nearly at all in administrative duties. When there is cooking, washing, or other household and family-supportive work to be done, they will often stop anything else they are doing and prioritize these activities. The older working age group was delineated by gender such that the women identified to fit within the other specified characteristics (e.g. actively participating in the production of coffee) would be directly invited, especially those who managed their own coffee parcel and who were known to the research team to engage in conversation and share opinions. There was no sign that these invites caused any harm to the women. Some came on their own, some came with another woman, some brought children, and some came with their husbands, who in these cases had also been invited due to fitting the specified characteristics.

With all this in mind, subjects in FG1 included youth (aged 18-32), adult men (aged 33-63), adult women (aged 33-63), and elderly (aged >63) who qualified for inclusion based on: 1) active membership in the association, 2) fitting the specified age range, 3) having had access to an area of land dedicated to the production of coffee, 4) having had a coffee harvest in the 2015/16 season, and 5) being responsible for coffee parcel management or acting as direct support of the manager of a coffee parcel (Table 3).

Farmers in each age and gender group were also assessed using a second set of characteristics such that at least one subject with each secondary characteristic was present. Secondary characteristics were meant to best reflect characteristics of the indigenous cultures and experience in coffee production and sale that would be important to shaping a

Yepocapa farmer's perception of the SICFI project and the coffee hybrids. These were arrived at through discussion with the local research team and specialists at Anacafé. Secondary characteristics included being a second or third generation coffee farmer, having received 'Centroamericano' hybrids through the SICFI project, having received 'Marsellesa' hybrids through the SICFI project, and identifying culturally as K'iche, Kaqchikel, Mam, Achí, Pocomam or other (Table 3). While having received 'Centroamericano' hybrids was clearly an important characteristic, this was considered secondary because the team wanted to also capture perspectives of association members who did not receive the hybrids, as these individuals may have been resistant to adoption.

Table 3. Characteristics used to guide solicitation of FG1 participants. Primary and secondary characteristics, as described in the text, are denoted with solid and hollow bullets, respectively.

Strata	Characteristic
Youth (aged 18-32)	● Parent(s) active members of the association for more than 2 years ● Aged between 18 and 32 years ● Parent(s) had access to an area of land dedicated to the production of coffee ● Parent(s) responsible for managing a coffee parcel or acting as direct support to the primary manager of a coffee parcel ● Parent(s) had a coffee harvest in the 2015/16 season ● Involved in management activities of the coffee parcel ○ Parent(s) first, second, or third generation coffee farmer(s) ○ Parent(s) received 'Centroamericano' hybrids through the SICFI project ○ Parent(s) received 'Marsellesa' coffee plantlets through the SICFI project ○ Identifying culturally as K'iche, Kaqchikel, Mam, Achí, Pocomam or other

Table 3. Continued

Strata	● Characteristic
Adult Men (aged 33-63)	● Active member of the association for more than 2 years ● Aged between 33 and 63 years ● Had access to an area of land dedicated to the production of coffee ● Responsible for managing a coffee parcel or acting as direct support to the primary manager of a coffee parcel ● Had a coffee harvest in the 2015/16 season ○ A first, second, or third generation coffee farmer ○ Received 'Centroamericano' hybrids through the SICFI project ○ Received 'Marsellesa' coffee plantlets through the SICFI project ○ Identifying culturally as K'iche, Kaqchikel, Mam, Achí, Pocomam or other
Adult Women (aged 33-63)	● Active member of the association for more than 2 years ● Aged between 33 and 63 years ● Had access to an area of land dedicated to the production of coffee ● Responsible for managing a coffee parcel or acting as direct support to the primary manager of a coffee parcel ● Had a coffee harvest in the 2015/16 season ○ A first, second, or third generation coffee farmer ○ Received 'Centroamericano' hybrids through the SICFI project ○ Received 'Marsellesa' coffee plantlets through the SICFI project ○ Identifying culturally as K'iche, Kaqchikel, Mam, Achí, Pocomam or other
Elderly (aged >63)	● Active members of the association or had been within the last 5 years ● Aged older than 63 years ● Had access to an area of land dedicated to the production of coffee within the last 5 years ● Responsible for managing a coffee parcel or acting as direct support to the primary manager of a coffee parcel within the last 5 years ○ A first, second, or third generation coffee farmer ○ Received 'Centroamericano' hybrids through the SICFI project ○ Received 'Marsellesa' coffee plantlets through the SICFI project ○ Identifying culturally as K'iche, Kaqchikel, Mam, Achí, Pocomam or other

Group 2: Association Leaders

Group 2 included the leaders of the associations: President, Vice President, Treasurer, Secretary, and others, depending on positions on the Board of Directors of each association. The purpose of holding separate meetings with the leaders was to collect information from subjects holding important roles in the associations, while also avoiding the potential of the leaders' presence to inhibit associate members from speaking freely (Grudens-Schuck et al., 2004; Narayanasamy, 2009). These individuals are community leaders, likely to have been involved more directly in the interactions with SICFI project personnel throughout planning and hybrid introduction. They are more aware of details of phenomena such as changes within the association structure, cooperative-level coffee sales, and past interventions. As such they provided a member check of the timeline and mobility map created earlier in the day by the associate members in FG1. Number of farmers per FG2 varied based on attendance (response to invite) and number of positions existing within the leader group (Table 4).

Table 4. Characteristics of farming and leader group participants.

Group	Ages			Gender	
	18-25	**26-50**	**50+**	**Male**	**Female**
Farmers					
ECA Montellano	5	7	4	12	4
Maya Kiché	1	6	4	7	4
San Pedrana	3	5	7	12	3
Assoc. Chuachilil	0	6	8	12	2
COFEAG	4	5	3	7	5
ECA Chuachilil	0	8	6	10	4
Total	**13**	**37**	**32**	**60**	**22**

Table 4. Continued

Group	Ages			Gender	
	18-25	26-50	50+	Male	Female
Leaders					
ECA Montellano	0	6	4	9	1
Maya Kiché	0	0	2	2	0
San Pedrana	0	1	3	4	0
Assoc. Chuachilil	0	0	2	2	0
COFEAG	0	3	1	4	0
ECA Chuachilil	0	1	2	3	0
Total	**0**	**11**	**14**	**24**	**1**

Data Collection Procedures

Setting

On the day of the FG the participants and full research team convened at the central meeting location of their association, as per invite by the *Promotor* their association was working most closely with through the SICFI project. The *Promotores,* being most familiar with the associations and physical settings in Yepocapa, were instructive in the decision of where the meetings should take place. It is sometimes recommended that having a single location for all interviews may reduce variation during data collection. However, when this was discussed amongst the team it became evident that, in this case, having each meeting at a location unique to that association would produce a more homogeneous experience for participants. Each association has a salon where they regularly hold meetings, some are also used to house equipment, process, dry, store and sell coffee. These locations are accessible to members, many of whom arrive there from home by foot, and who must know the location due to taking part in meetings or delivering their coffee to these locations during harvest season. As familiar settings the associates were much more

comfortable sitting for long periods of time and sharing their information there than they would have been had the groups been required to meet at the same location, which would likely have been in the town of San Pedro Yepocapa. An unfamiliar setting would likely have produced many more distractions than these familiar ones.

Designed as meeting spaces, all locations were quite well suited to the FGs, having stackable plastic chairs, at least one large table, and either a large, heavy white board that could be propped up or hung, or a wall where the poster paper for the mobility map and timeline could be taped in full view of the group.

Room and Team Configuration

To reduce any impression of interrogation, care was taken that the research team was seated or standing at the same level as the subjects, in the same type of seating (i.e., plastic chairs provided by the association). The room was configured such that the subject group sat in seats around a working area used primarily by the study coordinator and principle investigator, and facing a wall or large board where the exercise activities could be drawn (Figure 11). There was at least one large table available in each salon, which was placed at the front of the room and where consent forms, ballpoint pens, and the markers, sticky notes and tape needed to complete the exercises were kept. In this way all materials were visible to subjects and in easy reach of both the research team and subjects as they took part in the exercises.

Discussion and exercises were led by the study coordinator who was always at the front of the room (except during breaks), often standing but sometimes seated. The principal investigator was positioned toward the front of the room, to the side of the study coordinator so she could take part in discussion and ask questions as needed. From this

position she could see facial expressions of all subjects, maintain eye contact with the full research team, and clearly see the board or wall where the exercises were to be drawn. The *Promotores*, acting as observers, sat at the back of the group where they could watch all interactions, hear the full group discussion and any side conversations, and clearly see the posters being created at the front of the room. *Promotores* were instructed to only interject into the discussions when directly addressed and as needed, for example, when there was a question about a colloquial term used by a farmer or when the whole group of locals was trying to remember the date of an event.

Figure 11. Room orientation for the focus groups can be seen here. Study coordinator at the front of the room, directing conversation, the principal investigator at his side, and the rest of the research team seated behind the subjects (the third *Promotor* is taking the photo).

Introductions

At the beginning of each meeting the study coordinator introduced himself, the *Promotores*, and the principal investigator (though in many cases he and the *Promotores* were already known to subjects), the reason for the meeting, and the objectives to be achieved. During the introduction, the study coordinator would share expectations for how the meeting was expected to flow, explaining that the discussion would begin with the creation of a timeline of the history of the association, moving through all important events and experiences, and ending at the present day. The principal investigator was introduced as a doctoral student in horticulture from Texas A&M University, who was interested in learning about the experience of smallholder coffee farmers. Care was taken to explain that she was carrying out an evaluation of the SICFI project, but that she was not directly involved in the project herself. Though at the time, the principal investigator was not an advanced Spanish speaker, it is important to establish rapport with the subjects, so she stood in front of every group and gave a short introduction, saying each time (with help from the study coordinator), that she wanted to learn about coffee farming in general, including the obstacles, and in regard to the new coffee hybrids. It was explained that the *Promotores* were in the role of assistants for the meeting, to help facilitate the exercises and make observations. Subject groups did not show a varied reaction to these introductions, though some had experienced previous interactions with the study coordinator and *Promotores*.

Consent

Consent and a description of the purpose for the exercises took place for the first 20-30 minutes of each focus group. The study coordinator, acting as group moderator, read the

consent form to the subjects. He explained that their participation was entirely voluntary, that receiving plantlets or any other involvement with the SIFCI project in no way depended on their willingness to take part in the FG nor their answers to any of the questions asked, and that no identifying information would be attached to their responses. Participants were given time to ask questions and read and sign the consent forms before the discussion was begun. It was explained that the issues the participants faced, in the production and sale of coffee, were important to the coffee industry, and that their answers would be reported (anonymously) back to the industry and used in planning ways to better help support smallholder coffee farmers. General terms were purposefully used in these conversations to reduce expectation that the FG activities had any implications aside from the present discussion (e.g., the research team was there to listen to the stories of the farmers, not to support any agency interested in purchasing their coffee). Subjects were made very aware that they could opt out, of the study itself, or of any part of the discussion or questioning, at any time. They were also asked not to repeat anything they heard during the discussions outside of the FG, as the one main threat to subject anonymity in FG is that other participants witness their additions to the discussion (Merriam, 2009). As much time as was needed was allowed for discussion about the nature of the information being collected, and to assist members in signing the documents, usually taking between 20 and 30 minutes. Some members were comfortable holding a pen and had a signature they seemed comfortable using, while others were offered a pad of black ink, which they could use to provide their marked consent in the form of a thumb print. The local research team assisted these members by making sure everyone had access to a pen and/or ink pad, and showing them the line on the consent form where the signature was requested. Discussions

did not begin until all participants had been given ample opportunity to ask questions and voice any concerns.

Observation

As the FG included several hours of discussion each, in a language secondary to the primary researcher, it was not realistic to record and transcribe the conversations in full. In place of this, observations were made by the research team throughout the discussions. Narayanasamy (2009) defines observation as "a systematic viewing of specific phenomenon in its proper setting for the specific purpose of gathering data for a particular study" (p. 301). Observers were expected to record information on development interventions, innovation, CLR, pests and pathogens aside from CLR, coffee prices, coffee markets, weather shocks and climate conditions. Aside from these important categories, observations included notable group dynamics, body language, whether or not all subjects responded, if some questions seemed to garner more emphasis or response than others and if subjects appeared comfortable speaking up (Merriam, 2009).

To facilitate the observations being made about the target information the principal investigator and *Promotores* recorded observations on a previously constructed rubric (Appendix C), developed from the list of research questions and expected observable interactions amongst participants. The rubric provided a uniform format for data recording and was designed to streamline debriefing discussions and alleviate the potential for personal biases of the research team to affect the data. Rubric sections were developed from the list of research questions and expected observable interactions amongst participants to provide a consistent format for data recording and establish a directive for the observations (Krueger & Casey, 2014; Merriam, 2009). The rubric used by the

principal investigator was in English, and for the *Promotores* it was in Spanish. All were printed on white paper and clipped to a wood-backed clipboard so they could be written on while standing or seated.

The study coordinator, who was too active to take lengthy notes was given a hard-backed, palm-sized notebook where he could quickly record notable words and phrases to help him remember specific points for discussion amongst the team at the end of the day. All members of the research team were instructed to make note on the observation rubric if subjects reported a significant issue not previously known or that seemed to contradict what they understand to be true, instead of interjecting or opposing what the subjects stated.

Data Analysis

First-level Analysis: Post-Focus Group Meetings

Initial analysis was done in the field; all five members of the research team met within an hour of the ending of the last FG each day to discuss their observations (Krueger & Casey, 2014; Narayanasamy, 2009). The timeline and mobility map from that day were hung where the team could see them, and each member had their observation sheet in front of them. These raw data were used to facilitate conversations, which lasted about four hours each, and provided the first phase of analysis by combining observations made by the whole team into one document. This was also an opportunity for the locals in the research team to explain anything the principal investigator or study coordinator had not understood due to language barrier or lack of context. Documents produced in these meetings, representing both FG1 and FG2 with each association, provided a detailed

record of the group-level information shared by participants from each association, and were the primary form of data used in further analysis.

Second-Level Analysis

Second-level analysis followed the constant comparative method, which "involves comparing one segment of data to another to determine similarities and differences" in a deliberate, purposeful, sequential manner (Krueger & Casey, 2014; Merriam, 2009, p. 30). While often discussed in conjunction with grounded theory, the constant comparative method is also widely used in other forms of qualitative inquiry (Merriam, 2009). The method is inductive and comparative, meaning that concepts, hypotheses and theories are derived from the data (inductive) by comparing segments of information and assessing their likeness to one another (comparative) (Merriam, 2009). Where likenesses are found, data are grouped together (sometimes called a "bin") and, as a group, they demonstrate a theme of significance. For instance, if one subject mentions an issue with a specific coffee pest, but no one else discusses it, the pest may be something that affects just the one, or very few farms. While one farmer may be quite adamant that this pest is a problem, the purpose of the research was to identify themes that are generalizable to the community. If many other subjects described having issues with the same pest, the mass of responses would demonstrate that this pest is a common issue, and should be considered significant by investigators. By analyzing such themes, theory and hypotheses can be derived. Reports produced in the post-FG team meetings were the main form of data analyzed in this manner, supplemented by the team's field notes, timelines, and mobility maps to identify themes of importance (Krueger & Casey, 2014). Data from the reports were compared to one another to identify common themes, and ultimately, the range and dominance of

experiences for farmers across all six associations (Morgan, 1993). Chapter 4 presents the themes that emerged from these data groupings. In Chapter 5 these are compared to the Rogers model *Stages in the Innovation-Decision Process.*

Establishing Credibility, Generalizability, and Replicability

Credibility

One of the main issues with participatory data collection methods, as with most qualitative research, is credibility (i.e., confirmability) of results (Anney, 2014; Cavestro, 2003). In essence, the question is, how much confidence can the reader have that what is stated as true is in fact the truth? Two main threats to credibility are, 1) participants masking the truth or reporting untruthful information, and 2) that there is bias on behalf of the researcher who is analyzing the results. In this study, the researcher relied on open-ended questions and democratic decision-making of the participants in the focus groups, who discussed the information amongst themselves and, amongst themselves, decided what they found to be most accurate. Only then were answers written on the timeline or mobility map or recorded by the research team. Adding to this, the local research team was called on to perform the first phase of analysis, where all responses heard within the focus groups were discussed amongst the five team members and recorded into each association's FG report once consensus was reached. This prevented language and culture barriers, or personal opinion, on behalf of the principal investigator to bias the group-level results.

The primary researcher kept a reflection journal during the focus groups and her time in Guatemala. Through this activity, a researcher is able to identify their own presumptions or biases and separate those, in order to be as objective as possible in

analyzing results (Anney, 2014; Merriam, 2009). The participatory nature of the focus groups, and full, prolonged immersion of the principal investigator to the region (and to coffee production in the region), improved trust level of subjects and helped develop a much greater understanding of the culture and context (Anney, 2014).

Credibility was further strengthened through triangulation, one of the most well-known methods of confirming results in a study such as this one (Merriam, 2009). Triangulation is the practice of drawing conclusions through multiple forms of inquiry (usually three, but sometimes more) to most accurately identify an unknown point (Berg, 2001). Merriam (2009) suggests three common triangulation strategies: employment of multiple methods, reviewing multiple data sources and/or engaging multiple investigators (p. 215). All three were employed in this study: a 5-member research team included local agronomists and non-local research scientists; multiple associations were interviewed, including two sub groups (associate members and Board of Directors) within each; multiple forms of data were produced, in the form of timelines, mobility maps, answers to the research questions, and observation that was strengthened by prolonged engagement; and by verifying dates of particular interventions, plagues and weather/climate events through media publications and other sources to substantiate subject responses. These data were collected through interactions with the farmers themselves, in the two separate FGs with each of the six associations, with supporting evidence coming from observations made by the primary researcher and research team, visits to the coffee parcels, WCR and Anacafé reports, artifacts provided by the associations, and general investigation using web-based and in-print sources. Where direct questions were asked of subjects, they were open-ended and asked in the exact same manner in each group, being very careful not to

lead participants to their answers in either the initial or probing questions (Krueger et al., 2001). Under these conditions, if the groups said something similar to one another (especially where all groups had similar answers) this was considered a credible, important result.

Member Checks

Member checks are a common and important form of validation that comes directly from the subjects themselves (Merriam, 2009). Member checking involves and asking subjects to view the data to verify if they accurately depict what the subjects felt was said, and what they in fact experience (Merriam, 2009). The participatory nature of the proposed research included built-in member checks; subjects were involved in a preliminary analysis as they discussed issues amongst themselves, deciding by group consensus what most accurately reflected reality faced by most farmers in their region and only once a decision was made, writing this information into the mobility maps and timelines (Narayanasamy, 2009). Additionally, the focus group procedures (Appendix A) were designed such that the Board of Directors for each association, in FG2, reviewed the timeline and mobility map created by associate members earlier that day, in FG1. During FG2, the Board of Directors had opportunity to add to or edit these documents, and often did change dates of events or add more detailed information. The FGs provided data that informed further observation and investigation, ensuring subject participation and perspective was maintained as a central component throughout the study.

Generalizability

While some studies call on statistics to generate analyses that are generalizable to the rest of the population, and therefore must also rely on probabilistic sampling (e.g., random sampling), qualitative research relies on other measures to achieve generalizability (Merriam, 2009). The multisite case study is a "common strategy for enhancing the external validity or generalizability" of qualitative research findings (Merriam, 2009, p. 50). The present study collected and initially analyzed data from six distinct associations separately. Participants from each association were selected for invite to focus groups based on characteristics that best represented the farmers in the region, which the local team members and specialists at Anacafé identified as being the most likely to have effect on intent to adopt coffee hybrids (Krueger et al., 2001). Through these methods, the study results are generalizable to the Yepocapa region.

Transferability

Rogers' *Stages in the Innovation-Decision Process*, a widely used and accepted theory of human behavior, was compared to the Yepocapa case, with the purpose of increasing transferability. Transferability can be thought of as generalizability beyond Yepocapa, with the general question being, how well do the results presented in this study, which focused on the Yepocapa region of Guatemala reflect similar phenomena – smallholder producers' intent to adopt new coffee hybrids – in other regions or countries. As stated by Yin (1992), "theoretical formulations [calling on previously constructed theory] then become the main vehicle for developing generalizations from the case study findings" (p.124). Results of comparing the experiences the Yepocapa farmers to Rogers' model, in the Yepocapa farmers' first learning about the new coffee hybrids, interacting

with the project that introduced them, and their preliminary perceptions of the hybrids themselves, provides two forms of transferability. One, the results from Yepocapa can be added to the body of knowledge on adoption of innovation, and two, Rogers' model, which has shown extreme generalizability across a myriad of contexts, is assessed for its applicability to the case of smallholder coffee farmers receiving a newly developed coffee hybrid through development intervention. If the theory is found to hold in this context, then that provides evidence that the theory presented in Rogers' model is transferable to other cases. If the theory is not found to hold, then the fact that Rogers' model may not be a good yard stick by which to assess smallholder intent to adopt coffee hybrids introduced via development, which is also a transferable finding, though not as positive as it means future research should find another theory to help explain behavior in this context.

Replicability

In order to truly replicate this study, you would have to use the same instrument – you would have to employ the principal investigator of this very study. However, by describing the methods in detail (e.g., the setup of the room and role of the research team), the reader is best able to view salient characteristics which may be applicable to another case (Merriam, 2009). For instance, in this case, it was decided that having the FGs at the central meeting location of each association would be the most comfortable and accessible to the farmers. However, someone attempting to replicate the present study in another region may decide, through discussion and advice of a local research team, that holding all FGs in the same location would provide a more homogenous experience for participants.

CHAPTER IV

RESULTS

Introduction

Results stated here are associated with the four research objectives, with every effort having been taken to 1) allow themes of focus to come directly from the farmers themselves, 2) filter the information through the local lens, and 3) verify and validate the information provided by the farmers by substantiating and triangulating with other sources. The results in this chapter are presented by describing the main obstacles to production and sale of coffee experienced by the Yepocapa farmers, as well as project characteristics and farmer perspectives that affected their intent to adopt the 'Centroamericano' hybrids. Twelve themes were identified, eight representing obstacles to production and sale of coffee and four related to characteristics of the SICFI project. These themes, listed below, are described in detail in this chapter.

Obstacles to the production and sale of coffee:

1. Low and variable coffee prices
2. Limited market access
3. High costs of coffee transport and field management
4. Debt and lack of land title
5. Access to processing and drying facilities
6. Lack of education and planning
7. Natural factors
8. Theft of coffee

Project characteristics and farmer perspectives:

1. Past development in the region
2. Confusion between the term “hybrid” and “GMO”
3. Plantlet health
4. Processing facility

Obstacles to Production and Sale of Coffee

Low and Variable Coffee Prices

During the focus groups described in Chapter 3, all groups were asked the question “What are your biggest obstacles to producing and marketing your coffee?” Every group reported low prices as one of their main obstacles, which they unanimously believed resulted from lack of access to better or more direct markets (Figure 12). They explained that, through the methods of sale they had available, they receive very low prices for their product, providing insufficient income and thus prohibiting investment in updates to parcels or management practices, maintenance of field management throughout plagues like CLR, purchasing needed equipment, or in sustaining livelihoods.

Figure 12. The Board of Directors of COFEAG discuss their methods of sale and issues in processing with the research team.

All groups reported that they seek work outside of coffee production to make ends meet. One Chuachilil woman said coffee supports about 50% of her household; her husband tends the coffee year-round and she does other jobs to bring in the rest of the income they need. Both the associate members and Board of Directors of ECA Montellano said they bring in about 60% of their income from coffee and the other 40% from other activities. When asked what they would do if they made more money, most groups said receiving higher prices would allow them to produce, transport and process their coffee more efficiently and in greater quantity. Several also responded that they would be able to provide better opportunities for their children, especially in the way of education. Members of COFEAG, the youngest of the associations, were the most specific: they would buy a large-scale coffee dryer and a truck, which they believed would vastly increase the amount of coffee they could process and reduce the work in drying and transporting. Their current

practices involved substantial effort to carry sacks of coffee cherry from the parcel to the mill and wet parchment from the mill to a soccer field down the road, where they piled it on long pieces of thick black plastic to dry (Figure 13). Members of Asociación Maya Kiché, the most resource-poor of the six, said they would buy a depulper to separate the pulp from the seeds prior to fermentation, and to build drying patios, which would allow them to sell processed coffee and obtain better prices than they did currently by selling in cherry.

Figure 13. A COFEAG member holds out a few beans from this year's crop. In the background, coffee is spread out on black plastic sheeting covering the soccer field down the road from the mill.

In about half of the focus groups there was a discussion about the variability of price. Some spoke of receiving a much better price in 2006 (300 GTQ per *quintal* of cherry, equivalent to ~38 USD[15]) and a "reasonable price" (not specified) as recently as 2014, but said that prices in the subsequent years were not good enough for them to fulfill their own basic needs or keep up with the fumigation regiment needed to properly treat for CLR (Table 5). The farmers said the variability in prices negatively affected them in a big way because they could not depend on receiving what they considered a good return, and this question was present in their minds as they made decisions about investment in tending and harvesting each season (Figure 14). If they could be more certain of the prices they would ultimately receive earlier on in the season, they would know how much they could afford to invest in the coffee for that year. It was also explained that some investment needed to be made in keeping the coffee healthy no matter what the current market was. According to two Chuachilil farmers, if they didn't invest in a base level of fertilization, pruning, weeding, and treatment against disease, plant health and cherry production would be compromised for the following three years.

[15] Based on March 1, 2006 exchange rate, as reported by Oanda (https://www1.oanda.com/currency/converter/)

Table 5. Peak season prices received for coffee over the last ten years through all methods of sale, as reported by the farmers during the focus groups.

	Price (GTQ and ~USD equivalent**/qq)					
	Low		Expected		High	
Cherry prices	**GTQ**	**USD**	**GTQ**	**USD**	**GTQ**	**USD**
ECA Montellano	60	8	80	10	150	21
San Pedrana	132	17	175	23	200	27
COFEAG	70	9	80	10	110	14
ECA & Assoc. Chuachilil	60	8	100	13	150	20
Parchment prices						
ECA Montellano	634	84.5	700	93	880	113
San Pedrana	660	88	815	108.5	1000	133
COFEAG	780	104	732	97.6	700	93
ECA & Assoc. Chuachilil*	n/a		n/a		n/a	

*ECA and Association Chuachilil have no access to processing facilities.

**Conversion rates based on August 31, 2017 exchange rate, as reported by Oanda (https://www1.oanda.com/currency/converter/), and rounded up or down to the nearest integer.

Figure 14. San Pedrana members discuss their beginnings as an association and explain how prices have fluctuated over time.

Limited Market Access

Lack of access to good markets was reported by the farmers as their greatest obstacle to producing and selling coffee. They see this as a missing factor in receiving a better price for their product and a few asked the research team if they knew of a way they could sell more directly. There are four avenues of sale commonly utilized by smallholder farmers in the region: 1) selling through the association they belong to, which usually has a contract with a larger buyer such as FEDECOCAGUA; 2) selling directly to COEX, a large-scale buyer at a large coffee farm (*finca*) located near the town of Hermogenes Montellano; 3) selling to an association other than that which the farmer is a member; and 4) selling to a *coyote*.

Coyotes are men who drive pick-up trucks around coffee growing regions, purchasing coffee directly from the farmers and delivering to large mills, such as those on estate farms near Antigua. These men often have a standing relationship with the farmers and purchase from the same ones each year. Though they pay very low prices, selling a substantial amount of the harvest to *coyotes* was reported among all farmers and across all associations, considered a "necessary evil" because they pay cash for the coffee on the day of sale. An additional benefit to selling through *coyotes* is that they are willing to collect the coffee in fairly remote areas, reducing the need for the farmers themselves to facilitate transport, though there is a charge for this service. Selling to a *coyote* requires only that the coffee is harvested and put into sacks in cherry, then transported to a meeting location which can be at or near the parcel. Selling to a contractor through the association requires the coffee cherries to be transported from the parcel to the mill, held in fermentation tanks, de-pulped in a specialized machine, transported to a drying patio or heated dryer, tended to

and physically turned and stirred until it is dry (usually 7-15 days on a cement patio or plastic sheeting laid out on a field), and guarded 24/7 so it is not stolen, then re-sacked and transported to a safe location that will not dry the coffee too much or impart moisture or unwanted flavor. Additionally, transport, and labor outside of what the family does themselves, both come at a monetary cost. After all this is done, the associations may wait months to be paid for their coffee, at a market value that varies widely from year to year.

However convenient, all farmer groups expressed that *coyotes* do not pay very much for the coffee they buy. According to Asociación Chuachilil, the *coyotes* were expected to pay 55 GTQ (the equivalent of ~7.45 USD[16]), per 100 pounds of coffee cherry at mid-harvest time in the coming 2017/2018 harvest season, but were paying less than that at the time of the focus groups because it was the beginning of the harvest period and the large mills, which receive the coffee purchased by *coyotes*, were not yet in operation. Similar to this lower expected price at the beginning of the season, *coyotes* also reduced the prices they were willing to pay towards the end of harvest, as the larger mills shut down for the year and the main outlet for *coyote*-purchased coffee would close for the season.

Only one of the six associations had an export license. With the help of Yepocapa Coffee, San Pedrana received their license to export in 2016 as part of a plan to sell to US roasters. A license is required for exportation from Guatemala and the associations need to achieve this in order to engage in direct-sale opportunities. The licensing process was

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[16] Based on August 31, 2017 exchange rate, as reported by Oanda (https://www1.oanda.com/currency/converter/)

perceived by most of the farmers as complicated or otherwise difficult. According to an ECA Montellano board member, if their organization were to seek an export license, they would likely be given the run around and told to come back to the various offices located three hours away in Guatemala City many times before progress would be made. It was described that smallholder farmers are seen as lower-class citizens by people with jobs in the city, and thus were purposefully alienated and disregarded. He thought the licensing process would take three years at minimum, with active participation on the part of the farmers to keep returning to the various offices for multiple meetings at each step of the way. According to him, if someone from the United States were to accompany them, the meetings would more likely happen during the days on which they were planned, and the entire process could take as little as one year. These sentiments were confirmed through discussions with others in the industry, and by the experience had by the members of San Pedrana when they sought their license. Multiple individuals from the United States who were involved in the process of supporting San Pedrana in obtaining license to export described helping understand and complete paperwork that was more complicated than that which the farmers had experience. Additionally, there were steps in the process that required dogged persistence and long periods of time to complete, seemingly because the responsible official did not appear to want to be helpful, instead seemingly purposefully causing stalls that sometimes lasted for months. The San Pedrana Board of Directors believed that each of these steps would have been impossible or prolonged for even longer, possibly indefinitely, without the insistence and continued assertion of their US-based supporters.

Only three of the six associations (COFEAG, ECA Montellano, and San Pedrana) have any method of processing or drying coffee and only these three have association-level contracts with a larger buyer. Association members sell partially through the organization they belong to, to fulfill this contract, and partially to *coyotes*. In the case of ECA Montellano, they reported selling 50% of their crop to *coyotes* and 50% through the association. According to all groups with contracts, the contracts simply state that the organization will sell a specified quantity to the buyer and that the buyer will purchase that amount. The final price to be paid for the coffee is decided at the end of the season when the global C-market prices[17] have been set. Payment by the contractors is not made until the end of the season, usually March or April. Under this arrangement the amount they will receive is uncertain until the end of the season and the farmers wait for up to several months for compensation (depending on when they harvest).

Just one contractor was mentioned by all farmer groups as working directly with their association, an organization by the name of *Federación de Cooperativas Agrícolas de Productores de Café de Guatemala* (FEDECOCAGUA). It was suggested that FEDECOAGUA had a monopoly on the coffee produced by smallholders in Yepocapa and other regions, having been the main party involved in these relationships for several decades and inserting themselves between the farmers and any other buyers showing interest in the coffees produced there.

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[17] For description of the C-market, see https://www.theice.com/products/15/Coffee-C-Futures

All US-based individuals in contact with the Yepocapa farmers at the time of the study, including the principal investigator, saw evidence that the reported forcefulness of FEDECOAGUA was indeed present. Documentation was needed throughout some steps of the export licensing process of San Pedrana, showing record of the quantity of coffee produced over the years, which was sought from contacts at FEDECOAGUA as they had been a prominent buyer of most of the Cooperative's coffee for many years. This was met with both outward and indirect obstinance, as FEDECOCAGUA administrator(s) refused to be helpful, and, when they did acquiesce, the requested paperwork was supposedly lost multiple times and for periods of time lasting months.

The principal investigator visited the organization's main offices in Guatemala City, where she was enthusiastically received. Over the course of two days she met with FEDECOAGUA leaders, and visited the main offices, green coffee storage and cupping facilities, and a large association representing smallholder coffee producers of Acatenango, a town and region bordering Yepocapa that also contracts with FEDECOAGUA. During the Guatemala City visit, the principal investigator was shown a promotional video depicting FEDECOAGUA's activities and some of the grower groups whose coffee they purchase and resell. San Pedrana was featured prominently in this video, which was seen as evidence that, of the 148 smallholder associations FEDECOAGUA reportedly represents (FEDECOCAGUA, 2018), San Pedrana's story and product is of particular importance to business relations. According to FEDECOAGUA administrators, their organization provides a crucial service to Guatemala's smallholder coffee farmers, as they collect, process, store, certify and market the coffees to international buyers. They explained that they absorb the cost and upkeep of all of this, which would be

insurmountable to the smallholder communities. However, when asked if they provide feedback on quality, or the ultimate buyers of the coffee to the farmers, they said that they do not. They did say that they pass on price premiums to the associations when the coffee sells for more than a base rate, which the farmers in the present study either did not know about or did not mention during the focus groups.

Three of the associations (Maya Kiché, Associación Chuachilil and ECA Chuachilil) have no processing or drying facilities, therefore they have three options for selling coffee: 1) they can sell to one of the other associations in the region, an act which has monetary and potentially negative social costs associated, 2) sell to *coyotes*, or, 3) they can sell to an exporter called COEX (*Commercial Exportadora S.A.*[18]), which buys cherry directly from individual farmers both in cherry and parchment. Option 3 is only possible if the farmer can transport their coffee to the Finca Santa Elisa, an estate farm and mill located on the hillside a few kilometers above the town of San Pedro Yepocapa where COEX operates.

The associations charge a fee for services utilized by farmers outside of their own membership and not all are on good terms with one another. As an example, the Associación Maya Kiché was established when several members of ECA Montellano left to form their own organization after a disagreement occurred between members over repayment of their communal debt. Because they essentially dissented from ECA Montellano, which runs the mill, Maya Kiché farmers had no processing facilities of their

[18] More information on COEX http://www.coexgroup.com/about

own and were constrained to selling cherry to *coyotes* or transporting bags of cherry to Finca Santa Elisa. The members of Maya Kiché expressed disinclination when asked if they ever processed their coffee through ECA Montellano's mill due to their negative history and because they would have to pay a charge to do this. Several individual farmers did report bringing at least some of their crop to COEX.

High Costs of Coffee Transportation and Field Management

The cost/obstacle of transportation often necessitates selling to *coyotes*, who will collect coffee and make payment near to the parcel. Very few farmers have any motorized vehicle. Only the President of San Pedrana, the most resource-rich association in the project, mentioned using a motorcycle or truck for his regional travel and farm activities. Without a motorized vehicle, the farmers transport coffee sacks via mule or horse[19], on their backs with the use of a tumpline (strap that goes over the forehead, seen in Figure 15, or by hiring a driver with a pick-up truck. Farmers can be seen bringing coffee into the San Pedrana mill on their backs and with the use of animals (Figure 16), but distance and product volume often dictate the necessity of hiring a truck.

[19] There is one man in the town of San Pedro Yepocapa who keeps a handful of horses and mules. Farmers who know him can rent the animals by the day. In order to rent, they must schedule their time with the animals because several families in the community use this service and harvest for everyone occurs simultaneously.

Figure 15. An elderly farmer uses a tumpline to carry a *quintal* (100 lbs.) of coffee to the San Pedrana mill.

San Pedrana is the only organization that buys agricultural products (fertilizers, fungicides) in bulk and sells at a discount to its members. All other farmers purchase their own products individually, as opposed to purchasing collectively as an association. It was commonly stated that the lack of income due to poor coffee prices reduced the ability to fumigate adequately for CLR, however prices of the products themselves were only brought up during the making of the mobility map, when farmers were asked where they travel to in order to purchase their products. Most farmers said they purchase what they need in Yepocapa or somewhere else close by, such as the town of Acatenango, where they can buy inputs by the kilogram and gallon. The President of San Pedrana said they would receive a 25% discount on some products if they got them directly from Anacafé in Guatemala City but they tended not to do this because driving to the capital is 3-hour trip

each way. He did not specify which products they purchase in bulk or which the farmers purchase on their own.

Figure 16. A family unloads coffee from their horses at the San Pedrana mill.

Members of ECA Chuachilil and Associación Chuachilil reported walking for up to 3 hours to reach their parcel. The pick-up driver charges 5 GTQ (~0.70 USD[20]) per *quintal* to transport from the parcel to Yepocapa and 8 GTQ (~1.10 USD) from the parcel to the Finca Santa Elisa. COFEAG pays 5 GTQ (~0.70 USD) per *quintal* to move coffee from the parcel to the mill. *Coyotes* also reduce the amount of pay by this amount when they pick up closer to the parcel instead of in town, paying only 50 GTQ (~7 USD) instead of 55

[20] This and all other transportation prices reported in this section were based on August 31, 2017 exchange rate, as reported by Oanda (https://www1.oanda.com/currency/converter/)

GTQ (~7.35 USD) per *quintal*. By these reports, in the case of selling to *coyotes*, roughly 10% of the price received by the farmers is spent on transport or pick-up.

The Finca Santa Elisa paid 155 GTQ (~19.6 USD[21]) per *quintal* of cherry in the 2016/17 season. Since 8 GTQ must be spent to have the coffee transported there, total income reached 147 GTQ (~18.5 USD) per *quintal* of cherry, a substantial improvement on what the *coyotes* pay. Even so, the Associación Maya Kiché, which sold only to *coyotes* and COEX, reported selling the majority of their product to *coyotes*, which may either be a result of issues in hiring a driver or due to the fact that COEX does not set a price or pay out until the end of the season. See Table 6 for a listing of all transport costs and cherry prices reported throughout the focus groups.

Table 6. Transportation costs and prices paid for coffee cherry as reported by the farmers.

Buyer/Location	**Cost/Price per *Quintal***	
	GTQ	* USD Equivalent
Sale Price		
FEDECOCAGUA (COFEAG)	170	23.28
FEDECOCAGUA (Montellano)	176	24.10
COEX at Finca Santa Elisa	155	21.25
Coyote picking up in Yepocapa	55	7.50
Coyote picking up at parcel	50	6.85
Prices paid in 2006	300	41
Transportation Cost		
From parcel to Yepocapa	5	0.70
From parcel to COEX at Finca Santa Elisa	8	1.10
From parcel to mill (COFEAG)	5	0.70

*Conversions are based on rates at the time of the focus groups: 1 USD = GTQ 7.3

[21] Based on March 31, 2017 exchange rate, as reported by Oanda (https://www1.oanda.com/currency/converter/)

Debt and Lack of Land Title

All of the associations have had some history with debt, though the current relationship is quite varied. When the associations first formed, they purchased their land and mills with loans from a bank, called BANDESA at the time the initial loan was made, becoming BANRURAL in 1997 (Trivelli & Piselli, 2007) or FEDECOCAGUA. ECA Montellano made this initial purchase for 750,000 GTQ in 1990, which was supposed to be paid back over the next ten years. There were issues with repayment and by 2014 the debt had reached over 2 million GTQ. Montellano farmers are now back on a payment track and payments are made towards the debt every harvest season by association members. Montellano farmers describe the heavy payments as a major burden, which cuts into their already low income. San Pedrana took out three loans from FEDECOCAGUA in 1970 and 1971. The first was 2,200 GTQ, for the purchase of land where their offices were built. With the second loan they purchased a truck for transporting coffee to the exporter they did business with at the time. The third was for the amount of 90,000 GTQ, to buy the Santa Isabel mill (located in San Pedro Yepocapa, where they still operated at the time of the focus groups) and a substantial amount of land. These three debts were all paid off by regular contributions from the membership. In 2012, San Pedrana took on a new loan of 120,000 USD from BANRURAL for investing in the coffee parcels, which was to be paid back by 2016. When they were unable to pay it by then, they requested a ten-year extension from the bank, but were granted five.

Due to previous or current debt, not one of the farmers or associations in the project holds the title to their land. Lack of title restricts their ability to receive further loan assistance, which some of the farmers described as a serious concern. ECA Montellano and

Maya Kiché farmers had not held their land titles since first moving to the region in 1990 (Figure 17) because the debt, taken on to purchase the land and mill, had not been fully paid off. COFEAG, which was established in 2013 and was therefore just 4 years old at the time of the focus groups, had paid off their land but was unable to receive the title because a few of the people who were listed on the original agreement had died and therefore could not be present to finalize things with the bank. None of the other associations reported having the title to their land, for similar reasons.

Figure 17. Photos of the village Hermogenes Montellano, very rustic at the time of first settlement in the early 1990's, now the location of both the ECA Montellano and Maya Kiché coffee grower associations.

Debt led to conflict amongst association members in at least one situation. By the year 2000 there was enough unrest amongst the members of ECA Montellano due to conflict over repayment of their debt that 30 members left and formed their own organization, the Asociación Maya Kiché. Since then, about 60 more members had

dissented from the organization because they also did not want to pay the debt, leaving the existing members burdened with more to pay than they felt was their fair share. Aside from debt, there may have been cultural issues affecting this conflict. The village of Hermogenes Montellano, home to both ECA Montellano and Asociación Maya Kiché, was settled by migrants from four different regions of Guatemala (Totonicapán, Sololá, Colomba and Aguacatán). The principal investigator saw some evidence of this conflict, when a few farmers said that those from the coast did not have the background to grow coffee well. There may have been other cultural or ideological divides at play, which were not investigated for the present study.

Access to Processing and Drying Facilities

Only three of the six associations had their own processing or drying facilities. Asociación Maya Kiché, ECA Chuachilil, and Asociación Chuachilil did not have a mill, dryers, or patios and were therefore restricted to selling to c*oyotes*, COEX at the *Finca Santa Elisa*, or one of the other associations. ECA Montellano, San Pedrana and COFEAG each had their own mill and drying facility, though all three were restricted by their drying capacity and none had adequately sized or climate-controlled space to store their processed coffee (Figure 18). Not a single association reported processing all the way to green coffee, thus they all sold in cherry or parchment, typically of lower value than coffee that has been fully processed and sorted.

Figure 18. The President of COFEAG looks at the uniformity in a handful of beans from the beginning 2017 harvest.

San Pedrana's mill, located in the town of San Pedro Yepocapa, had the highest milling, drying and storing capacity of the six, with a large wet mill, a large well-built building, and big patios (Figure 19). They did have space in a large salon for storage, but had found that keeping coffee in this space imparted a bad flavor and changed the moisture content of the coffee (Figure 20). They did process coffee for some of the other farmers in the region at times, but said they did not have the capacity to mill, dry, or store coffee aside from their own during peak season. Montellano had a smaller sized wet mill, patios, a wood-fired dryer and an old electric dryer that was out of repair. They were limited in what they could process and dry but could do more if they had more patio space or if the big air-dryer was restored to working order.

Figure 19. Drying patios adjacent to the mill run by San Pedrana.

Figure 20. The salon at the mill run by San Pedrana, full of coffee sacks which will be stored here until they are sold.

COFEAG owned a wet mill, donated to them in 2012 by the AGTEC project, which was funded by USAID and implemented by the Borlaug Institute for International Agriculture at Texas A&M University. There was very limited patio space around the mill, so they used the packed dirt area around the mill and a soccer field down the road as a drying patio. Here, they laid out long sheets of thick black plastic on which they piled the coffee for drying (Figure 21). It seemed a very time-consuming system because they had to lay out the large lengths of plastic before placing the coffee on it, then cover and uncover the coffee with the edges of the plastic every time rain threatened, and rake out then re-cover the coffee each time this was done. At the very least, this system required uncovering and then covering the coffee once per day, at the beginning and end of the day, but the principal investigator witnessed workers performing this task many times over the course of an August day, when the rainy season was at its tail end and showers were still passing through the area.

Figure 21. COFEAG employees spread wet parchment over thick black plastic to dry as part of their morning routine. They wrap the coffee in the plastic sheeting when it rains and at night, re-laying and raking it out in the mornings and after the rains move away.

One of the project's objectives was to renovate old milling equipment. In 2017, a new de-pulping machine was installed at the mill belonging to San Pedrana. Only after the new machine was put in was it realized that the electricity running to the mill was not sufficient to power it. The Board of Directors explained that they were in contact with someone about putting in additional power lines to run more electricity to the mill, but that this type of thing can take a long time to accomplish in Guatemala. According to the President, putting in the new power lines will require hard-to-get signatures. At the time of the discussion they were unsure of when they would make progress on this issue and could not run the depulper in the meantime.

Lack of Education and Planning

Many farmers spoke of wanting training, in management of their coffee, in business, and regarding coffee quality. The research team was asked on at least two different occasions if there was a farm the association members could visit to learn how to manage their coffee for better results. San Pedrana, which reported regularly receiving training workshops from Anacafé and had been working closely with Yepocapa Coffee to raise quality, still asked this emphatically. A Maya Kiché man said he was in the habit of making a work plan for how he would manage his coffee each season, which he found very helpful and recommended to others, though he did not know of anyone besides himself who did.

When asked if they received trainings put on by Anacafé, in the past or currently, most groups said they did not. They had only become involved with Anacafé through the two projects that introduced the hybrids and they did not receive any regular trainings. The outlier in this was the San Pedrana Association, which did say they received visits and trainings by Anacafé, though they also said that this support was helpful but did not provide everything they need. One of their members told the story of a time when an Anacafé technician came to explain some things to their association and "the poor guy was overwhelmed," because everyone had so many questions. The principal investigator became aware after the focus groups that the members of Yepocapa Coffee had begun to engage Anacafé as a resource when seeking to certify San Pedrana as an exporter. These actions had occurred prior to the focus groups and could be related to the higher visitation received by San Pedrana than other associations. A COFEAG farmer said he had attended a talk given by Anacafé, which gave coffee management recommendations that he

followed on two of his plots. According to him, these are his two most productive parcels, "both are covered in coffee." He believed he would benefit from further such education.

Costs were described unanimously as one of the greatest obstacles to production. Every group reported that they do not make enough income to support their households through coffee, due to high costs of production and low value of the product. However, not a single farmer in any of the groups keeps a record of how much they spend throughout the season. Lacking these records, the farmers were unable to pinpoint where the bulk of their costs of production are going, nor were they able to say how much income is generated through coffee. Most groups realized that, to be more profitable, their own approach to the business of coffee needed to change. A member of the Asociación Chuachilil told the research team there exist three types of farmers in the region, 1) "cultural/ traditional," 2) "occasional," and 3) "production." According to him, all need to change their mentality and act like businessmen instead of producers.

Most of the time when quality was discussed by farmers up as a future goal it was followed with a statement such as, "but we do not have background in this, we need training to be able to do it." An Asociación Chuachilil member said he understood that market prices were based on quality and variety, so "if you don't have what the industry is looking for you will not be able to access more direct markets and better pricing." He followed this by saying that they know nothing about this and therefore had no ability to make their situation better by accessing better markets, though they wanted to. He was curious enough about cup quality that he roasted coffee from a 'Catimor' variety and another of his varieties at home and tried them side by side to see if he could detect a difference. He liked the 'Catimor' better.

Natural Factors

Climate changes most notable to the Yepocapa farmers include varied rain patterns, warmer weather, stronger winds, and drought. Most groups said temperatures had increased since the 1990s and it now rained with sporadic intensity and timing that made farming difficult. According to COFEAG and Maya Kiché, the rains used to start in February and March but were now so varied "they did not know what to expect anymore." ECA Montellano farmers said the rains came later now, in April, but that it was better for farming than when the rainy season began earlier, in January, February, and March. Asociación Chuachilil explained that their "coffee flowers started to break early this year (2017) due to a bout of February rain, and were then dried out and killed by a subsequent wind." One of the Associación Chuachilil farmers told the team he had changed to planting his corn at a different time of year than he used to; he could no longer go by his long-used planting schedule because of the changing rain patterns.

Drought was a big problem in the 2016/17 season, killing young coffee plants and reducing yield of mature ones. According to the farmers, the coffee puts on a normal amount of fruit early on, but does not fully mature when there is not adequate moisture in the soil. An ECA Montellano member said there used to be a spring on his land, but it had recently dried up due to drought.

Wind was brought up several times throughout the meetings. Strong rains and wind were now coming during the harvest season, causing damage to the crop. Wind kills coffee branches, dries out flowers and fruit, and kills young plants. Strong October winds caused leaf drop around the time of harvest and negatively affect production. Wind was also a

factor in the death of hundreds of 'Centroamericano' hybrids given to the farmers in 2014 by a development project.

Pests and diseases were reported as highly prevalent on the Yepocapa coffee farms. The pests themselves were not usually reported as the main obstacle, however a lack of good prices, which was reported by all groups as one of their biggest obstacles, was almost always accompanied by an explanation that, with better prices, the farmers would be more able to combat the plagues. CLR, *ojo de gallo*, nematodes, phoma, and anthracnose were discussed the most, though coffee berry borer and *vano grano* (underdeveloped bean) were also mentioned. According to San Pedrana and ECA Chuachilil, CLR infected plants are weakened and susceptible to other diseases, such as *ojo de gallo* and anthracnose, which cause worse damage or kill the plant.

An ECA Montellano board member joked that he did not know what varieties he had anymore because so many had died, grown, and been replanted in attempt to manage CLR and other diseases. One San Pedrana man described having some nice Caturra plants that had recently become infected with CLR and he was concerned. "If all my plants get *la roya* (CLR), how am I going to eat?" Some farmers believed CLR was spread by hurricanes. ECA Montellano started having problems with rust in 2008, three years after Hurricane Stan, and Maya Kiché reported that the CLR epidemic was worst in 2013, three years after Tropical Storm Agatha. COFEAG was also affected by both Stan and Agatha, which they said brought CLR to the region. ECA Chuachilil reported beginning their fight against CLR in 2009, around the same time as ECA Montellano. All reported being unprepared to manage CLR.

Nematodes were a pervasive problem in the 1980s and 1990s, pressuring coffee producers to change varieties and switch to grafted plants. Bourbon varieties used to be common but were switched out for others that were less susceptible, such as Caturra and Catuai. After a few years, these same varieties were planted in grafted form, but it took almost a decade for grafted plants to be accepted by the majority. Though virtually all coffee in the region was now grafted onto the Robusta rootstock 'Nemaya,' nematodes were still a problem when grafted plants were not used. A COFEAG farmer showed the researchers a young plant of his, which had recently been killed by nematodes. The plant was about 90-cm tall, defoliated, and had a splayed taproot, which the farmer pointed out as evidence of nematode infection (Figure 22).

Figure 22. Nematode damage on coffee plants. Left: A young un-grafted coffee plant which had recently been killed by nematode infection. Right: The splayed taproot exhibited as evidence of nematode infection.

Insect populations were reported to be changing along with the weather. Members of the Asociación Chuachilil said they were seeing a type of fly in the area, which used to be found only on the coast. The fly was not a known coffee predator but was brought up in the discussion because the farmers believed this migration was due to changes in climate. ECA Chuachilil spoke of a caterpillar they called "the little bird" because it looks like it has feathers, which eats leaves and stems of the coffee plants. In the previous season there had been very few "little birds" sightings but in the current one (2017) there had been many.

Most of the farmers described the nearby Fuego Volcano as a major obstacle. Fuego continuously erupts, spreading caustic volcanic ash across the region, which the farmers say burns the leaves and flowers of their crops. The research team can attest to the constant activity of the volcano; Fuego was often loudly spewing magma and ash in the background during the focus groups and there was a constant fog of ash particles both falling and suspended in the air above San Pedro Yepocapa (Figure 23). San Pedrana and others described losing all of their plants and having to start over with new stock as a result of an eruption in the 1970s.

Hurricanes were reported by all the associations as major interruptions to coffee production. Hurricanes Mitch and Stan hit the region in 1998 and 2005, respectively, and Tropical Storm Agatha came through in 2010. Maya Kiché coffee was damaged badly in hurricanes Mitch and Stan, which defoliated most of the coffee plants. According to multiple groups, the storms reduce yield for one to five years after they hit because it takes this long for the plants to recover from the damage.

Figure 23. August 2017, Fuego erupts in the background, spewing ash into the air. In the foreground a street in San Pedro Yepocapa is covered in ash.

Theft of Coffee

Theft of ripe berries from the field is imminent in some cases if the farmers do not harvest prematurely. Harvesting only mature coffee is an issue Yepocapa Coffee had been addressing with the San Pedrana Association, which tended to harvest before full maturity because their coffee had high probability of being stolen if it remained in the field until fully mature. According to several farmers, *coyotes* drive around San Pedro Yepocapa and will buy bagged coffee from anyone, so thieves have an easy market. Members of Maya Kiché reported theft as more common when prices were higher and also more prevalent in parcels located closer to town. This statement was supported by San Pedrana, which has its mill and meeting place right in the town of San Pedro Yepocapa, and whose members spoke most outwardly about theft and its effects. They said it was usually people that did

not own land who would steal coffee from those who do, and there were unemployed people in the region who did not own land. When asked how thieves knew when and where to go to steal, the farmers said they watch the activity of others throughout the year, to see when they go to their parcels and when they take part in activities such as church, which provides an opportunity when thieves could count on them not being at their parcel. Most theft was occurring either late at night, in the afternoons after the farmer had left their parcel for the day, or on days when the farmers went to church. The associations with a mill and storage space guarded their facilities around the clock during harvest season. San Pedrana had plants and products stolen from their compound in 2016, just the year before the focus groups, and had since kept two watchmen on site throughout the night. Maya Kiché had no mill or enclosed storage space (Figure 24).

Figure 24. The Asociación Maya Kiché salon and meeting location, with no doors or windows to enclose the space. The motorbike belonged to one of the research team members.

Factors Affecting Hybrid Acceptance

Past Development in the Region

Most, if not all farmers who received the 'Centroamericano' hybrids from WCR in 2016, had also received the hybrids as part of a 2014 project implemented in the region by another, much larger organization[22]. Due to a few key deficiencies, this previous project had an overall negative effect on the farmers' perception of the hybrids' qualities. The main issues were 1) the grafts were done poorly and many of the plants died, 2) the plantlets were delivered in the plastic bags they were grown in and some farmers planted them with the bag still on, 3) there was no training associated with the introduction of the new hybrids, and 4) there was no supplemental support in the form of fertilizer or other resources with which to help the farmers establish the new plants. The biggest problem in this previous (2014) project was the plants themselves. The seedlings had been grafted using a simple splice graft, which the farmers said is not appropriate for use in coffee. The splice graft, called an "X graft" by the farmers, is made by cutting both rootstock and scion at an angle, joining the two exposed surfaces, and binding with horticultural tape or a clip until the graft takes (Figure 25). According to the farmers, a cleft graft, which is referred to as *reyna* or "queen" graft, is much better for coffee. This more effective graft involves cutting the tip of the scion down two opposing sides, creating a flattened point (Figure 26). This point is inserted into the rootstock, which has been split down the middle, and bound with tape or a clip until it joins. The *reyna* graft is much stronger because it is wedged

[22] The name of this organization is being omitted here, on request by World Coffee Research.

down into the rootstock as opposed to just being joined along one angle and the two parts make contact on two sides instead of just one.

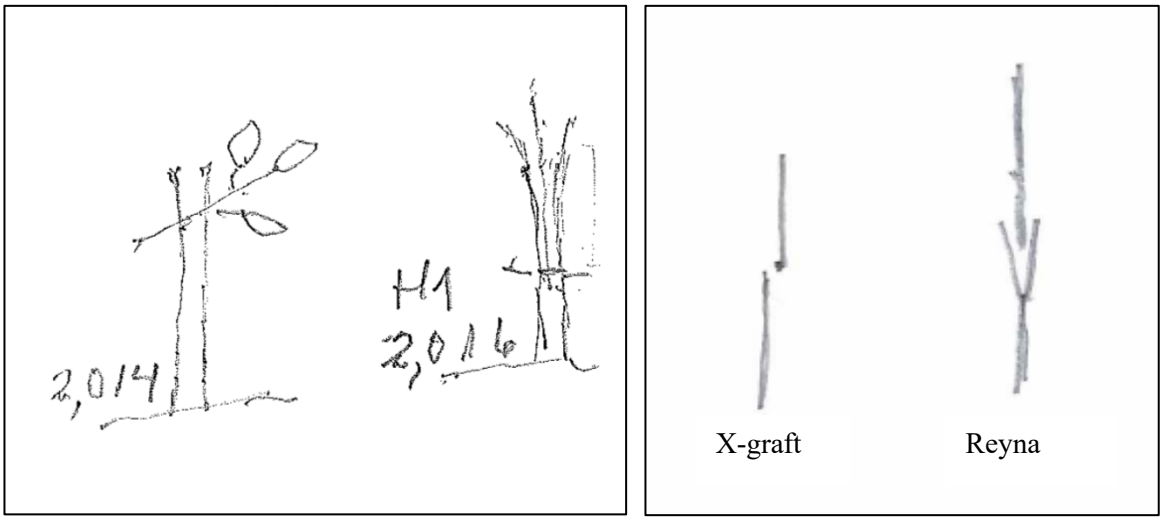


Figure 25. Pictures of the different grafts seen in the plantlets from each project, drawn by farmers from San Pedrana (left) and ECA Chuachilil (right). The "X" graft, shown on the left in each picture, and the reyna, or "queen" graft is shown on the hybrids received in 2016. According to this farmer, the graft should be 5-cm deep for best results.

Figure 26. A COFEAG farmer demonstrates differences between the shallow "X" graft (left) and deeper *Reyna* graft (right). He tilted the *Reyna* graft example to emphasize that the length of scion that should be inserted into the root stock should be substantial.

At least two of the associations do their own grafting and took the time to explain that, for best results, the scion should be inserted deeply enough that 5 centimeters of rootstock and scion are in contact with one another (Figure 26). According to the farmers, a high percentage of the hybrids they received in 2014 broke at the graft union, often early on, but some mature plants continued to fall two and three years after planting. The least amount of loss was reported at 60% and the highest at 100%. A COFEAG member said he received 200 plants, but all had died. A man from ECA Chuachilil said he received 340 plants but had 200 left. In some cases, the same farmers who spoke of problems with the hybrids did not list 'Centroamericano' when they were asked what varieties they currently had. When asked why they did not mention the hybrids, they said it was because virtually all the hybrid plants had died because of the problem with the grafts. Young plants fell over in the wind and the older plants broke when the farmers weeded and pruned. Some

said they were still breaking even three years later. These claims were substantiated when the principal investigator herself saw evidence in the field (Figure 27), with the latest sighting of mature plants that had broken off at a point close to the soil surface in December of 2018.

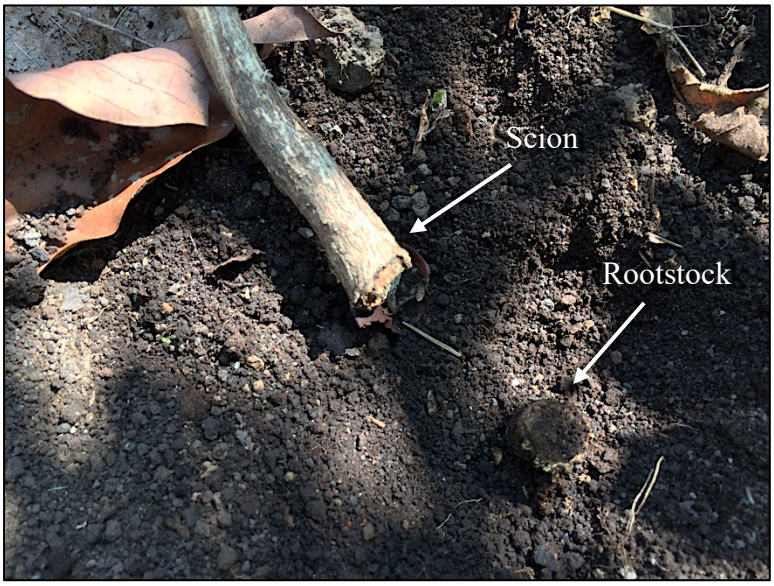


Figure 27. The desiccated scion and rootstock stump of one of the hybrids received in 2014, broken at the graft point. Photo taken in March of 2017.

Through discussion, it was suggested that wind may have contributed to the losses where they were highest, but this is unconfirmed. Fragile grafts of the hybrids donated in 2014 were described in every single focus group and demonstrated or drawn by at least one farmer in three of the focus groups. ECA Chuachilil expanded on the issue to say that some were not grafted at all, but were full Robusta seedlings with a clip where the graft should

be, and some even had the scion inserted upside down. The same was seen by the research team on other farms in the project.

Not only were these grafts done poorly, but the 2014 project gave no training on hybrid management. Many farmers planted their new plants directly in the plastic bags they were delivered in (Figure 28), not knowing to remove them, possibly leading to further mortality and variable health of the hybrids that did survive. The farmers of ECA Montellano explained that they planted the 'Centroamericano' plantlets just as they had come, in the bag, but that they did not grow well. More than one San Pedrana farmer reported that their neighbors' hybrid parcels were non-uniform, with some tall, vigorous and healthy and some yellowed, weak and small. They thought this variability might be because those farmers did not remove the bag when they planted. Failure to remove the plastic bag was also witnessed on a visit with one of the largest coffee producers in Guatemala. This farmer switched from plastic to Eco-pil bags[23], which are made of a gauzy biodegradable fabric that can easily be punctured by roots, because of issues with his crew not removing the bag when planting (Figure 29). Sometimes his workers did not even remove hard plastic reusable seedling tubes when planting into the field (Figure 30).

[23] A description of Eco-pil bags and their environmental advantages over plastic can be found on this webpage from Atlas Coffee: https://www.atlascoffee.com/el-salvador-mexico-2018/

Figure 28. Young coffee seedlings growing in the black plastic bags commonly used as seedling containers in Guatemala.

Figure 29 A coffee seedling grown in Eco-pil, a gauzy material now used by some projects and coffee planters to reduce plastic waste and potential for root inhibition. Seedling roots can be seen here growing through the Eco-pil material.

Figure 30. Hard plastic reusable seedling tubes used in the past by a large-scale coffee farmer but discontinued due to some workers not removing when planting.

The farmers did not differentiate between the previous project and the SICFI project. This was evident in a confusion that occurred throughout several discussions. When asked their opinion of the hybrids from WCR, which they had received just the year before, the farmers gave their impression of three-year old plants. Through further discussion it was understood that the farmers had received 'Centroamericano' hybrids from a previous project in 2014, and that is why they were discussing plants that seemed too mature to have been part of the SICFI project. In subsequent focus groups the research team referred to the hybrids as "2014 hybrids" and "2016 hybrids" and this made the discussions easier. Both the owner of Yepocapa Coffee and the documentarian Devon Barker, who filmed interviews with several San Pedrana farmers in early 2017, described a similar confusion and process of identifying which hybrids the farmers were discussing at

a given time. Both also said that the farmers they had had these discussions with had expressed hesitancy and mistrust regarding coffee hybrids and through further discussion they identified the mistrust as coming from negative experience with the 2014 project and plants.

Some do still have healthy hybrids from the 2014 project and were looking forward to experiencing their first full harvest in the coming months. San Pedrana farmers said they were hopeful the coffee from the hybrids was of high quality, as a few members were planning to separate their harvest by variety and sell to US roasters for the first time that year. One had pictures of the three-year-old hybrids on his phone, which looked healthy and had good fruit set to the principal investigator. Maya Kiché farmers said that, at the time this research was conducted, they could see that the hybrids grew well and were resistant to CLR, which had reduced the need to fumigate (Figure 31). One COFEAG member still had most of the hybrids he received through the earlier project, which the group thought may be due to there being less wind on his property. Overall, the hybrids that did survive had qualities the farmers appreciated.

Figure 31. Maya Kiché farmers discussing their perceptions of the 'Centroamericano' hybrids.

Confusion Between "Hybrid" and "GMO"

Fear of the hybrids being GMO, or "from Monsanto," came up in every group as a reason why many were originally hesitant to accept them. When asked what was unfavorable about GMOs, the common response was a fear of being "trapped" in an obligation to purchase expensive products and seed from one company. Some said they were afraid they would not be able to sell the coffee harvested from the hybrids. The example of Monsanto corn was given on more than one occasion. An Asociación Chuachilil member told the researchers there had been a great unrest in the country in 2014, including riots in Guatemala City, over transgenic plants. According to him, Monsanto wanted all the seeds in Guatemala to be theirs, but the country put its foot down against this. Because they were told, or had heard, that they should not save and plant the hybrid seed, many Yepocapa farmers thought the hybrids were transgenic and that they should resist them. It was confirmed that, between June and September of 2014,

indigenous and environmental organizations in Guatemala publicly demonstrated resistance to GMOs in opposition to a law called the “Law for the Protection of New Plant Varieties,” referred to by most as the “Monsanto Law” that would have allowed the privatization of seed genetics in the country (Grandia, 2017; "Guatemalan protests against the Monsanto Law," 2014). The law was overturned by the government on September 4 of that year, due to widespread rallying by indigenous groups (Lea, 2018). The previous project delivered ‘Centroamericano’ hybrids to the Yepocapa farmers in August of 2014, in the midst of this country-wide GMO dispute.

When asked why some farmers accepted them, ECA Montellano said they thought the people who initially accepted the hybrids did so because they were destitute after losing so much to CLR. Only one association, COFEAG, did not express concern for growing the hybrids. When the President of COFEAG was asked if there had been a change in opinion of the hybrids, he remarked that he knew of the rumor they were transgenic but said he did not share that concern because the transgenic issue “was about corn and not coffee.” He further explained that he saw it like this, “which has more force, a mule or a horse?” You cannot breed a mule, but because of its strength, it has utility on the farm. He saw the hybrids similarly. COFEAG was also clearest on which project the hybrids had come from each year and that the hybrids they received in 2014 were problematic due to bad grafts, not that the hybrids themselves were faulty. This association was the youngest in the study, formed just four years prior to the focus groups with the help of another development project, characteristics which may correlate with an openness to new technologies.

There were questions about the hybrids in each group. The reason for not being able to plant the seed was not understood and all groups were quite interested in the

explanation. If it had not come up earlier in the discussion, the question of why they should not plant the seed was discussed by the farmers after the group was asked their opinion of the hybrids. This question from them occurred so regularly, steering the conversation away from the study questions each time in order to explain, that the research team was instructed to table their response until after all study questions had been asked.

Overall, the farmers were hesitant to take on new technologies. ECA Montellano described the switch to grafted plants in the 1990s in response to the nematode problem as a very slow process which took the better part of a decade. According to the groups, some farmers planted a few grafted plants, then some intercropped grafted with non-grafted and eventually all planted grafted plants because they saw that their neighbors' plants had good fruit set, even on lower branches.

Resistance to the hybrids was most often described in conjunction with the initial introduction in 2014. It is possible that the GMO misconception had less effect on acceptance of the hybrids in the SICFI project. The previous project may have either demonstrated the benefits of the hybrids through the plants that did survived or allowed the farmers to see they were not from Monsanto, thus increasing their receptiveness to the hybrids two years later. However, due to the confusion between the two projects during the initial focus groups, this is uncertain. Regardless, the generally negative view of the hybrids appeared to be changing. One Maya Kiché board member said he could see now that the hybrids grew well and there was no problem with selling the coffee. ECA Montellano reported that 60% of their farmers refused the hybrids in 2014, but saw that the WCR project was different, and more were willing to take them then. The Asociación Chuachilil farmer who described the protests against transgenics said there was a lot of

"negative propaganda" about them in the beginning, but he could now see the plants as a resource for the association.

Plantlet Health

Late delivery of the hybrids was reported as problematic by three of the six organizations in the SICFI project. The board of ECA Montellano said deliveries from both the 2014 project and WCR came to them in late August, after the peak of the rainy season. Also, the WCR plants were small and there was a drought in 2016, which compromised the initial development and caused mortality, though not as high as was experienced with the plants received in 2014. This was corroborated by the Asociación Maya Kiché, whose members also said the hybrids came late during a dry year, and by ECA Chuachilil members who said the plants were small and arrived "very late." Losses were reported as high as 60% due to the timing, size of plants and drought, but those that survived were doing well and looking healthy a year later. Neither San Pedrana, Asociación Chuachilil nor COFEAG members made mention of the drought or late delivery, possibly because they had more water resources or received an earlier delivery.

The one issue inherent to the hybrids themselves is a higher nutritional demand. ECA Montellano reported seeing good yield and resistance in the hybrids, but said they need more fertilizer than other varieties. Asociación Chuachilil and ECA Chuachilil members said they had to fertilize the hybrids more than their other varieties. Asociación Maya Kiché farmers initially believed there was a deficiency in their soils because the hybrids turned yellow without extensive fertilization and a San Pedrana farmer said nearly the same thing.

CHAPTER V

CONCLUSIONS

Introduction

This chapter shares conclusions derived from the results of the case study. It also discusses implications that interaction with development interventions such as the SICFI project, and with newly introduced coffee hybrids, have for production and sale of coffee in the Yepocapa case. Adoption itself was not studied, thus the discussion analyzes results using the first two stages of the Rogers' model, knowledge and persuasion, as a measure of comparison. Another case, provided by a similar introduction of disease resistant coffee hybrids, is also examined. The chapter ends with a discussion of the role of development intervention in supporting improved quality of life for smallholder coffee producers and considerations for the stance these projects take in regard to their target beneficiaries.

Factors that Affected Intent to Adopt 'Centroamericano' Hybrids

Themes concluded to have notably impacted the Yepocapa farmers' intent to adopt the 'Centroamericano' coffee hybrids are as follows.

Socioeconomics. Interconnectedness between issues such as market access, price, theft, and quality are clearly evident. When theft is imminent, farmers pick before the coffee fully matures, resulting in a lower quality product. Low prices restrict farmers' ability to manage CLR and other diseases and do not provide enough income to maintain households. Lack of access to markets that pay based on quality reduces incentive to

better understand or increase quality. High transportation costs are an impediment to all and lead many to sell through *coyotes*, which pay the least. This interconnectedness is good news for development agents because it means that, by addressing key issues, multiple factors can be improved.

Cultural/political context. A misconception that the hybrids were transgenic, in the midst of a country-wide resistance to the implementation of transgenic organisms, caused many farmers to resist accepting them as a potential benefit. The farmers described this in phrases like, "we heard that you could be obligated to buy all of your agricultural inputs from one company, or sell your products only to them, if you use their seeds." There is implication here that the Yepocapa farmers did not themselves take part in the 2014 demonstrations against GMOs, but that there was a social pressure to resist technologies that restrict the replanting of harvested seed. The strongest response seemed to be perception of pressure from a company, which triggered fear of losing a level of autonomy in decision-making regarding farming practices. The perception that others had already resisted GMOs may have also triggered a feeling of loyalty to the ideas of the demonstrators. Some of the farmers' perceptions likely took into account that the actors against transgenics were mainly organizers of indigenous groups and therefore had cultural or class similarities to the Yepocapa farmers. These strong entities, with cultural similarities to the Yepocapa farmers, had already vetted the technology and not only decided against adopting it, but to strongly resist its permittance in the country.

Lack of understanding regarding reasons not to plant hybrid seed. Many farmers had heard from SICFI project administrators that they should not save and plant seed

from the hybrids. Lack of context around why it is not recommended to plant the seeds of an F1 hybrid led to the misconception that the hybrids were transgenic. This confusion led to skepticism of the hybrids and ultimate resistance to them as a potentially beneficial technology. Skepticism along these lines was brought up by the farmers in all but one group and that group acknowledged knowing many individuals who were mistrusting of the hybrids. Even many of the farmers who did have hybrids, from both the SICFI and 2014 projects, spoke about hesitancy to take the new hybrids for these same reasons. Some described accepting them because they were at such a loss for what to do about persistent CLR infestation. Some said they had accepted them hoping earnestly that they would be a benefit, but they still knew people in the communities who had not adopted based on the skeptical premise. The skepticism discussed, of the project and the hybrids clearly came from being told not to plant the seeds. The only context the farmers had to understand this request was the publicly demonstrated GMO resistance in 2014.

Demonstration of new technology. In the 1990s the farmers learned to accept grafting of coffee plants onto nematode resistant root stock slowly, due to pressure from pervasive nematode damage and witnessing the benefit to others. Parallel to that, in regard to the hybrids in at least some cases, farmers who had previously been skeptical described being more accepting of them after witnessing what were considered beneficial qualities and/or because their fears regarding control of proprietary genetics did not come to fruition.

There are two points to be made here. One is that the previous experience with grafting in this case can be seen as a hurdle that was already overcome. Grafting was at one point a newly introduced technology which the farmers described as having taken a decade to fully accept. Because widespread adoption of grafting had already been realized, through years of demonstration, it was not an obstacle by the time the grafted hybrids were introduced. The second point is that demonstration doesn't only facilitate witness to an innovation's benefits, it also allows potential downsides to be explored and better understood.

Quality and health of the plant material upon arrival. Quality of plantlets, even with improved and identical genetics, is a factor of how they are grafted, their maturity, the timing of delivery, and how well the farmers plant and manage them. Poor graft quality, small size, late delivery, and dry climatic conditions all negatively affected farmer perceptions of the 'Centroamericano' hybrids. Bad grafts of the same hybrids given by another project in 2014 put some farmers in bad situations where they had large expanses of land dedicated to the new plants, which died. These plants have been seen dead in the fields after having grown to 4 years of maturity and over six feet (2 meters) in height.

While genetics are controlled in breeding stages long before a development project designed to introduce them is underway and are thus not in the control of the project's administrators, the other factors are feasibly controllable. Graft quality and dates for seeding, taking cuttings, and delivery can all be planned well in advance, with contingencies in place for the case that something unexpected occurs. Climate conditions

cannot be controlled but delivery dates and instructions for care can be modified under climate changes to best ensure a quality product arrives under prime conditions, and that subsequent care given by recipients successfully targets health and sturdiness of the new plant material.

Farmer management of the hybrids. Once delivered, the farmers' own management, including non-removal of the plastic material used to contain the roots and rooting media, planting in windy areas, and nutrient application, had enough effect on growth rate and health of the hybrids to affect how the farmers perceived them. Some aspects of this, like the materials used in plant propagation; and existence of, clarity and cultural relevance of instructions on removal of plastics, ideal field placement, and field management, are possible for the project itself to oversee. Other aspects, such as willingness or ability of an end user to follow detailed instructions, is not. This showcases a need for assessment of the detailed context, including current field management methods, prior to a project's implementation and for tailored technical assistance following delivery of the new innovation. There was field technical assistance offered in this case, but somehow this did not mitigate these issues and did not seem to include assistance at the time of planting, instead being more targeted to supporting field management and data collection for the project.

Qualities of the hybrids at maturity. Vigor, higher yield, resistance to CLR and large, dense beans were all qualities of the "Centroamericano" plants which led many farmers to have higher regard for them. Good cup quality is also a characteristic of the hybrids the SICFI project anticipated would be of benefit to the farmers. However, in

this case there is no mechanism in place for selling coffee based on quality, which means it is both not incentivized and not a concept that is very well understood by the farmers. Some nuances of the relationship between cup quality, farmers, and development interventions are described in the next section.

A Mini Case: Effect of Study Results on Coffee Quality

Productivity Versus Quality

In coffee there are two distinct mechanisms for increasing income: higher productivity and better cup quality. Higher productivity, given a similar level of investment, is a logical target for improved profitability. The concepts of higher demand and "yield gap" are universal across most, if not all agricultural products, supply and demand issues notwithstanding. Quality levels in coffee change the entire economic model, shifting more to a focus on value per unit than on production of more units.

Commodity grade coffees can be thought of as being "pushed" out of origin, where the producers have to compete with one another for the market share, driving down price. Specialty coffees are sought after by buyers and end users, who send scouts around the world to find unique post-harvest processes and flavor profiles, seeking out and "pulling" these coffees from their origins. There is a different relationship between buyers and producers of specialty grade coffee than between those of commodity coffees; the value of specialty grade can be much higher because it is less tied to global market rates and more based on relationships between the producer and the buyer, and between the roaster and their clientele.

Entering the specialty market is considered an important target for smallholder producers, and for producers in general, as all are at risk of losing income due to market fluctuation and unfavorable environmental conditions. Producers of specialty coffees can get to know a buyer, often times cupping their own coffees and receiving feedback on how to target specific improvements in field management, time-of-harvest and post-harvest handling. There is more inclusion of the producer in this model than in the commodity case, where coffee is fed into what can be thought of as a stream running towards and through larger and larger mills and into the hands of exporters, which occurs until it fills cargo containers that are shipped to the US, Europe Australia, and parts of Asia. In the commodity case, the coffee becomes almost a literal flooded river of product, with individual units all mixed together, pushing its way out of origin. In a flood such as this no consumer will ever be able to identify, search out, or give acknowledgement to each little trickle (producer) adding tribute. In the specialty case there is less of a flooded river and something more like little pools that develop here and there, with much more opportunity for each producer to be identified and receive attention. Some buyers of specialty coffees are quite aware of specific constraints affecting producers and will devise ways of supporting a producer through a hard time to maintain the relationship. Some instances of this were seen in the CLR epidemic of 2012-2013, where buyers paid the same prices for damaged coffee as they did previously for higher qualities in order to support a producer through the worst of the epidemic.

Cup Quality in Yepocapa

Cup quality was not something that the farmers discussed much. Some were aware that cup quality is a goal and are interested in attaining good cup quality in their coffee but are also very aware that their current production practices and limited means of sale do not allow them to sell by quality or variety. A member of the Asociación Chuachilil said he would eventually be looking for cup quality in a new variety but this would only come after more important things, like access to better education on how to produce coffee more successfully, because "right now quality isn't something that makes much difference to us." When asked what characteristics they would look for in a new coffee variety some did respond that they would seek quality, though in every case it was mentioned toward the end of the list.

When asked what quality means to them, it was usually stated as the weight/density and size of the grain. This is beneficial from the farmer perspective because they can fill a *quintal* faster with larger, more dense beans, thereby having more units to sell and ultimately gaining more income while spending less time or paying less for the coffee to be picked. Therefore, at the moment, bean size and density are the only incentivized quality parameters. Without a market for specific quality or varieties there is little incentive to increase quality, reduce defects, separate by variety or quality, or even pick at full maturity. It should be noted that large bean size, high yield, and good density were qualities many of the farmers did say they were experiencing in the 'Centroamericano' hybrids, which they were impressed with.

Though about half of the associations mentioned cup quality as a goal, the research team questioned where the idea came from since none of these farmers have the ability to sell their coffee by quality and therefore none separate their coffee by variety, quality, or any other characteristic. When quality was mentioned during the meetings it was with less confidence and importance than was given to other characteristics, like bean size. Yepocapa farmers also have very little experience with their coffee after it is processed and sold, so have not been exposed to cuppings or flavor profiling. The coffee they themselves drink is very light in color and not brewed strong enough to smell or taste like coffee as US and European consumers would know it. Where Guatemalan farmers do keep some of their own crop to drink, its usually the least desirable grains and so of lower quality even than the bulk of commodity grade coffee they produce. Instant coffee is more common in households across Guatemala than ground coffee, and it is illegal to import coffee from other origins into the country.

The research team shared a coffee break with each of the associations during the FG meetings. Provisions for these were purchased from local families and therefore reflect their usual method of coffee preparation. The coffee was the same weak brew and light brown color in all cases. People from Yepocapa and other regions jokingly refer to this drink as "sock water." These experiences provided evidence that the Yepocapa farmers do not have the same expectations for the flavor or strength of brewed coffee as the ultimate consumer of their product. And, there is a wide knowledge gap around concepts of quality assessment, flavor profiling, and production methods that target quality and flavor.

The idea of cup quality may have come from interactions with a very newly founded US-based business called Yepocapa Coffee. The owner of Yepocapa Coffee and a Yepocapa local had been working with the San Pedrana Association since 2014 to raise the quality of their coffees in order to sell through more direct relationships with US roasters. Yepocapa Coffee had only worked directly with San Pedrana at the time of data collection. It is however possible that, within the three years that he had been working in the region, the notion of quality had spread. Though it cannot be said for sure, this potential origination and its relationship to better prices is supported by the fact that the associations that spoke about cup quality were Cooperativa San Pedrana, ECA Chuachilil, and Asociación Chuachilil, the three associations with facilities in the town of San Pedro Yepocapa. Asociación Chuachilil and ECA Chuachilil both share a central meeting location and have members and leaders who live in the same town where San Pedrana's mill and offices are located, and both reported selling some of their coffee to San Pedrana at some point in their history.

There is concern that the disease resistant coffee hybrids do not have the ability to reach cup quality potentials of full Arabica coffees. In preliminary cuppings of coffees from Yepocapa, and in other cases witnessed in Guatemala and elsewhere, 'Centroamericano' cupped at lower scores than all other varieties under the same field management, post-harvest handling and cupping preparation.

Two main points can be taken away from this mini case on cup quality. One is that there may have been more emphasis from the SICFI project on coffee quality than was necessary since the Yepocapa farmers are incentivized more by CLR resistance,

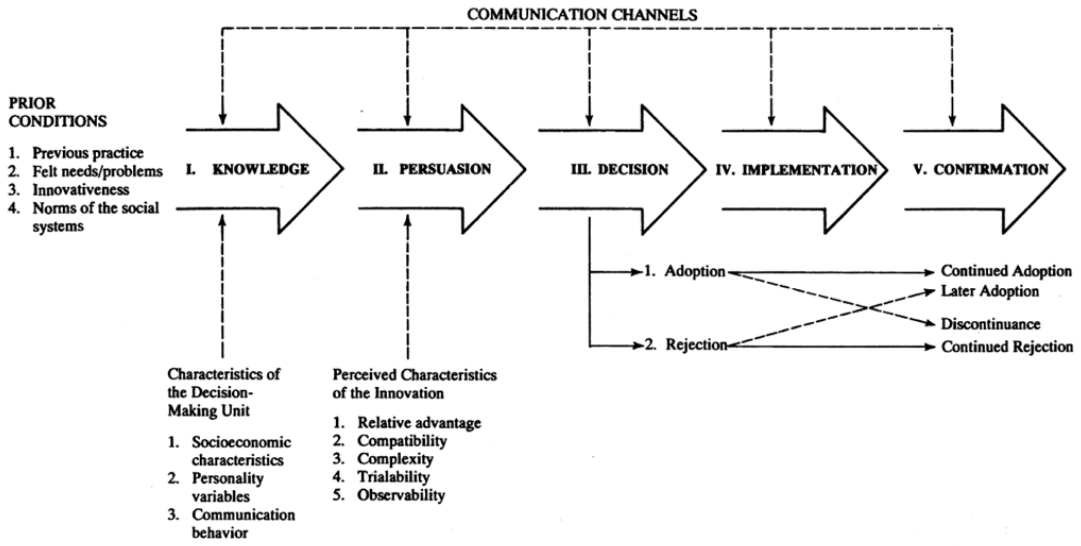
bean size, and productivity. Adding to that, emphasizing cup quality as a beneficial characteristic of the hybrids may have caused the Yepocapa farmers to have less interest in them since not only is there no mechanism of sale by quality in the region, but the farmers also expressed a feeling of being left out of specialty markets. They know some producers access higher prices through these markets, but *they* don't. A final issue which cannot be ignored is that, if 'Centroamericano' really does not have the potential to reach the cupping standards of the specialty industry, its implementation may ultimately reduce a farmer's potential to enter the specialty market, where the higher profit and more inclusive relationships with buyers exists. If this is the case, it may be irresponsible to introduce hybrids as an innovation to support smallholders.

Fitting the Rogers Model

The Model

In Rogers' *Five Stages of the Innovation-Decision Process* model (Figure 32), decisions to adopt a new technology are often based on characteristics of the adopter, characteristics of the innovation, and the mechanisms by which adopters gain confidence in an innovation's characteristics. Formal education received and socioeconomic status are emphasized as important adopter characteristics (Rogers, 2010). Socioeconomic context is often a crucial component of a farmer's ability to accept [and afford] an adaptive practice (Vignola et al., 2015a), and smallholder and resource-poor farmers may not be as receptive to a new technology (Banerjee et al., 2011; Bielecki, 2015; Pingali et al., 2005; Tucker et al., 2010). An innovation's characteristics must be visible (i.e., trial-able, observable, and not too complex), and beneficial (i.e., compatible with

existing systems and cultures, and providing relative advantage). According to this model, the decision to adopt or reject an innovation or new technology is founded in the knowledge and persuasion stages, which provide the basis for decision making, action and confirmation (Rogers, 2010).



The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

Figure 32. Rogers' Model of the Five Stages of the Innovation-Decision Process[24].

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Prior Conditions

Many nuances exist within the Knowledge and Persuasion stages, starting with prior conditions. Within this, Rogers lists *previous practice*, *felt needs and problems*, *innovativeness*, and *norms of the social system*. There is evidence in the Yepocapa case that prior conditions played a role in the farmers' decision-making. Roots of the misconception that the coffee hybrids were GMOs lay in the 2014 uproar of demonstration against the widespread use of transgenic organisms in Guatemalan agriculture. This appears to be a case of norms of social systems, where the farmers felt a duty to resist adoption of an innovation that might incite the kind of obligation to purchase all products from one company the demonstrators in 2014 acted out against.

Felt needs and problems, along with norms of social systems, were exhibited in the issue of coffee quality. While the farmers certainly expressed a need for coffee plants that could resist CLR, their intent to adopt may have also been negatively affected, if subtly, by lack of full grasp on the characteristic of cup quality when it was discussed as an attribute of the hybrids. These findings indicate that, for full project success, it is important to investigate existing biases against GMOs, in addition to better explanation of why it is not recommended to plant seed collected from mature hybrids.

It is quite clear how the connection was made in the minds of the farmers between the hybrids and GMOs. They heard that a project wanted to give them coffee plants, but that they should not plant the seeds of these plants, in the wake of a countrywide public outcry against use of privately-owned seed genetics. Focus group participants continued to ask throughout and beyond the present study for clarification

on the question of why they should not plant the seeds of the F1 'Centroamericano' hybrids. Saving seed from plants showing beneficial qualities and vigor is long engrained in the Yepocapa farmers, as they have been re-planting their parcels in this manner for decades, and in most cases multiple generations. It makes sense then that they would keep asking the question of why it is not recommended to save hybrids' seed. The continued persistence of the question and norms of the social system which include saving seed for replanting also infers that the farmers *will* save and replant using seeds collected from the hybrids. While some farmers may be more aware now of why they should not do this, it is likely that their neighbors are not as aware, since many association members and all non-members in the region were not involved as directly in the SICFI project and did not sit through hours of focus group discussions that touched on some of the reasons. These farmers will plant the hybrid seed, there is no question. Before the principal investigator left Guatemala, she heard from colleagues that farmers were already saving seed from the hybrids and re-seeding nurseries with the plantlets produced.

Rogers Model Stage I: Knowledge

A *knowledge stage* occurs when an individual becomes aware of the existence of an innovation or technology. Rogers emphasizes s*ocioeconomic characteristics*, *personality variables* and *communication behavior* in this stage. Rigorously assessing effects of personality and communication behavior on intent to adopt were outside the scope of this study. One inference to this was observed when the members of the association COFEAG did not mention the GMO concern initially as all the other groups

did. After several open-ended questions did not illicit the same response heard in all other groups, the COFEAG president was asked directly if he had ever heard of producers resisting based on the GMO notion. Once asked about it, the president said, "Oh, that. Yeah, I've heard that's an issue for some people, but it's not an issue for us." When asked to explain why not, he said, "I see it like this: which has more force, a mule or a horse? (he stopped and waited for the group to respond) The mule of course! You can't breed a mule either, but we all wish we had one." And then the group laughed. Trials of worm compost and fermented compost tea as a foliar nutrient input were later seen at COFEAG's central meeting location, where their mill, storage and small office are also located. It was not identified if there is a general tendency toward innovativeness at COFEAG, or if there was some external force suggesting these innovations be trialed, but this could be investigated further.

Socioeconomics was observed to play a very important role in the ability of the farmers to consider taking on a new technology such as the 'Centroamericano' hybrid. Every single group said distinctly that they did not receive enough income from coffee production to support their families or reinvest back into their coffee parcels. They all reported having to take on jobs aside from coffee production to make ends meet and insinuated in some cases that their other jobs helped them continue in coffee. This indicated that the farmers felt highly constrained by lack of income and were less likely to form an intent to adopt the hybrids when they felt coffee production was a less solvent activity.

Rogers (2010) describes three types of knowledge critical to efficient decision-making: *Awareness knowledge,* obtained when the individual becomes cognizant of the existence of the innovation; *How-to knowledge*, which includes the information necessary to use the innovation properly; and *Principles knowledge*, which involves an understanding of how the innovation works. According to Rogers, a lack of how-to knowledge often results in rejection, whereas a lack of principles knowledge may lead to misuse of the technology. All three are present in this case. Individual farmers became aware of the hybrids several months before plantlets were delivered, discussing and deliberating over whether the hybrids or the SICFI project would obligate them to do something they did not want to in the future. Deliberations were fueled by the awareness knowledge, that it was recommended by SICFI administrators that farmers not plant the hybrids' seed. Many farmers lacked how-to knowledge, therefore did not remove the bags the seedlings were transported in and may have planted the new plants on windy parcels and not fertilized as well as required. Lack of principles knowledge led to the farmers not understanding why they should not save and plant the hybrid seed, one of the most robust findings in this study.

Rogers Model Stage II: Persuasion

The *persuasion stage* occurs when a potential adopter evaluates information they have about an innovation and forms an attitude towards it, taking into account its perceived characteristics. Rogers (2010) describes five characteristics of the innovation that most affect its favorability and rate of adoption, including: *observability, relative advantage*, *compatibility*, *complexity*, and *trialability*. Relative advantage and

compatibility are positively correlated with acceptance, while complexity is negatively associated. Innovations that can be readily and easily trialed and/or observed are also more likely to be adopted.

In speaking with project personnel, the principal investigator noticed an emphasis on characteristics of the hybrids, as if they are able to facilitate their own adoption. To some extent this did happen; farmers mentioned that in their initial observations, the 'Centroamericano' hybrids seemed to grow well in the midst of persistent CLR, have large bean size, and were growing rapidly where there was no mitigating issue. There were, however, many mitigating issues. In absence of a demonstration plot developed well ahead of time, farmers receive very young plants and have to grow them out to more mature stages before they can observe their characteristics. This puts the relative advantage question on hold for multiple years, until the plant can be seen to produce well and garner high prices, the ultimate advantages sought. Important initial advantages were seen in CLR resistance and vigorous growth. Compatibility was brought to question when the farmers learned it was not advised to save and plant seeds from these new plants, something they have done historically. Complexity, of field management needs, and due to questions regarding the hybrid nature, were an issue at the time of the focus groups and may continue to be issues into the future. More investigation needs to be done to understand, in detail, field management strategies used by the Yepocapa farmers and if these are modified to support vigorous hybrid growth or not. Also, the farmers still wonder why they should not save and plant 'Centroamericano' seeds. Trialability was facilitated by the project itself, which gave the hybrids to the farmers.

Without the development projects that introduce the hybrids, farmers would have to access the plant material themselves, which would be a barrier for many in the Yepocapa case.

Innovation-Decision Model Fit to the Yepocapa Case

Many parallels were seen between Rogers' innovation-decision model and the Yepocapa case. It is therefore deduced that this model does provide a good framework by which to plan and carry out the implementation of projects that aim to introduce disease resistant coffee hybrids as a mechanism to improve socioeconomic conditions.

Additional factors affecting perception of new innovations

Findings from the Yepocapa case suggest parallel with the knowledge and persuasion phases of the Rogers adoption-decision model. They also suggest the need to supplement this model to include aspects of the introduction, and that agents facilitating this introduction may not be familiar with specific issues affecting farmers in the target region. There is an additional aspect of full understanding of the cultural and smallholder coffee producer context. It is recommended that these concepts are added to the to the first two stages of the innovation-decision model as supplements to help improve usefulness of the theory for cases such as the one in Yepocapa. To maintain transferability to other contexts, the principal investigator returned to the literature to investigate recommendations and findings from other studies of intent to adopt new innovation. The following are descriptions where similar phenomena were observed in other cases, which are added to the innovation-decision model in Figure 33.

While the hybrids do show characteristics that are of interest to the farmers, initial intention to adopt this perennial plant was clearly impacted by characteristics of their introduction. Characteristics of the project and the agent who delivers the innovation (i.e., hardware), information about it, and/or its unique management practices (i.e., software) can also greatly influence perception of the technology and the ultimate decision to adopt or reject (Kaimowitz, Snyder, & Engel, 1990; Rogers, 2010). While examining public sector services, Aarons, Hulrlburt, and McCue Horwitz (2011) found that acceptance of an innovation is highly influenced by "the degree to which innovation developers understand the challenges of implementation" (p. 13), and how well the innovation and intervention development processes involve stakeholders and reflect a clear understanding of their needs and challenges.

Project administrators can correct the issues if they understand the impacts they have on project success, which was one of the goals of the present study. Some factors are within feasible control of the agents designing the introduction, like timing of deliveries and age of plants upon delivery, and some, like climate or weather shocks that coincide with project activities, are not. "Centroamericano" hybrids show promise in helping overcome some of these obstacles, specifically through high yield, large bean size and resistance to coffee leaf rust.

Understanding the context prior to and during an intervention can help mitigate. For example, socioeconomic context is often a crucial component of a farmer's ability to accept [and afford] an adaptive practice (Vignola et al., 2015a), smallholder and resource-poor farmers may not be as receptive to a new technology (Banerjee et al.,

2011; Bielecki, 2015; Pingali et al., 2005; Tucker et al., 2010). And an individual's decision-making paradigm is a function of their perceptions of current, short-term and long-term circumstances (Bacon et al., 2017; Bathfield et al., 2016).

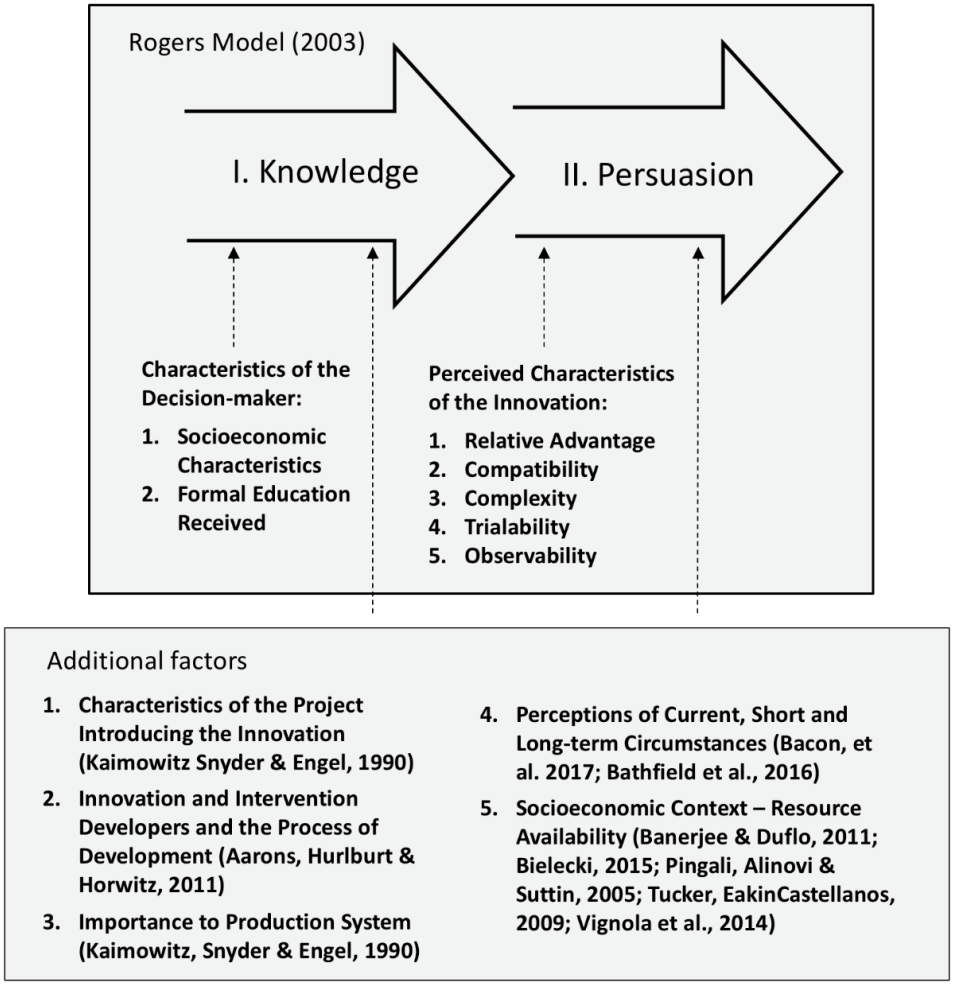

Figure 33. Factors affecting knowledge and persuasion stages in the Innovation-Decision Process

The 'Ruiru 11' Case

The case of the 'Ruiru 11' coffee hybrid, which was also bred for disease resistance and good cup quality, even having similar parentage to 'Centroamericano,' appears to have many parallels to the Yepocapa case. Results of studies by Nyoro and Sprey (1986a) showed that trialability and observability of beneficial characteristics of the hybrid was important to both estate farmers (farms of land area more than 8 ha, and as large as 140 ha), and to smallholders (having land less than 8 ha) (Nyoro & Sprey, 1986a, 1986b). Eighty percent of estate managers (of both irrigated and non-irrigated farms) put emphasis on needing to see a higher productivity from the hybrids before they would be willing to replace varieties currently in use. Replacement was expected to take more than 10 years, and in many cases 20 years, moving in a phased approach, and only after having 5-6 years of experience with trial plots. Of the smallholder group, 60% responded that they wanted to see the performance of the hybrid on another farm in order to be sure of its disease resistance and the other majority wanted to trial the hybrids themselves, on a small plot of land, prior to using them in renovation (Nyoro & Sprey, 1986a). These smallholders also had a tendency to want to trial the 'Ruiru 11' hybrids on one of their best pieces of land, though in a small amount (Nyoro & Sprey, 1986a). This was also seen in some cases in Yepocapa, which points to the responsibility of development agents to be careful in their recommendations – smallholders who already have myriad issues stacked against them and their food and family security are likely to lend meager resources, such as a healthy plot of land to trialing new hybrids, which puts them at risk of even greater food insecurity due to the opportunity cost of

producing another cash crop, or a food crop, on that same land. Seventy five percent of smallholder farmers in Kenya were not concerned about the investment needed for re-planting with the new 'Ruiru 11' hybrids because they thought they could get a loan (Nyoro & Sprey, 1986a), which is currently, and knowingly, impossible for the Yepocapa farmers.

Ultimately, after huge investment by the CRF and implementation across the country of Kenya, " the high cost of adopting the variety, shortages in planting materials and lack of awareness has severely limited wide scale adoption of the variety among smallholder farmers" (Karanja & Nyoro, 2002, p. 32).

Discussion

The 'Ruiru 11' case, and much of the literature shared in Chapter 2, are evidence that important considerations for introducing coffee hybrids and other agricultural innovations has been studied extensively. Yet, projects are still carried out without attention to the myriad sources of information that place importance on needs assessment to help understand the context in which innovations will be introduced, and evaluation to assess outcomes. The farmers of Yepocapa have been the recipients of coffee hybrids which the results of this study show may or may not be a solution to their main constraint in farming and household activities – low profitability. Development interventions assume there exists a culture and resource base to facilitate adoption and implementation of new innovations, and that farmers like those in Yepocapa will adopt innovations like new coffee hybrids simply because they come recommended by those who created and want to disseminate them.

‘Centroamericano’ hybrids do show the beneficial characteristics of CLR resistance, vigorous growth, and large bean size. But what if there is more benefit to leaving coffee production altogether for smallholder Guatemalan producers than switching to new varieties? There is much discussion, in industry, science, and press, about the ways to “keep people farming coffee.” Multi-million-dollar projects are paid for with taxpayer dollars, to do this very thing. Yet, there are plenty of known cases throughout history where CLR and other diseases still prevalent today have wiped out entire regions of production. Adding to this, prices have been so volatile in the last two decades that even resource-rich farmers are forced to consider leaving coffee production every few years. Production and price are both compromised by forces so far out of the reach of producers to control that breeders have to develop plants that can uphold both. These innovations do certainly have their place. However, it often seems as though they are given a higher place than the people involved in the deal, especially those who carry the most risk.

We know that even fully understanding all potential benefits of an innovation doesn’t mean the target beneficiaries have the resources to implement, or the education or experience to have confidence in their decision to adopt. In the case of smallholders, who manage an onslaught of stressors, and are often marginalized, they don’t often have the resources to modify long-term strategies quickly. They are forced throughout their lives to be slow to change, and to think only about the near future in their decision-making. Coffee is a perennial crop that takes several years to reach maturity, and thus any acceptance of change to the crop itself is a long-term strategy.

Logic follows that a person's perceptions about an issue shape their response to it. Rogers innovation-decision model has been implemented in myriad ways to showcase five progressive steps in the process of learning about and forming opinions of new innovation, that ultimately affect intent to adopt. If project success depends on adoption, why don't development agents spend more time studying these steps, and more budget on understanding how they play out in the context of the people they aim to serve? It seems there is a fear of hearing the truthful details of the experiences and perceptions of marginalized people that can coincide with the projects that aim to help them. Is there a more impactful way to help someone who has been marginalized than by caring fully about their life experience? These projects aren't just a way to help shuttle monetary resources into coffee origins, they can also be a conduit of information that helps build individual and community-level confidence in making salient decisions about their own future.

Paulo Freire wrote in 1968 that the world's poor, oppressed, and exploited are not to be seen as invalidated by their condition or circumstances, but are instead the most important and viable source from which contextual information and actionable change should come (Freire, 1972, 2000). Robert Chambers wrote in 1992 of the need for a paradigm shift in thinking and approaching problem solving for issues facing the world's resource poor and marginalized populations in his seminal work on Participatory Rural Appraisal in 1992. He states, however, that the concept of involving these individuals themselves in describing and responding to their obstacles had as of yet "remained a minority view among development professionals as a whole" (Chambers, 1992, p. 6).

In the 1940's, botanist and expert in tropical agriculture and coffee, Peter Cramer, wrote *A Review of Literature of Coffee Research in Indonesia* in response to a persistent "feeling of dissatisfaction and doubt" among coffee farmers, which remained though leading coffee research institutes at the time had recently hosted several discussions and lectures in response to a question raised by a famous coffee farmer, named N.M. de Ligt, about what contributions scientific study had made towards improved coffee production (Cramer, 1957). According to Cramer, "attempts to provide an answer were based more on theoretical considerations than on actual comparative statistics," and important questions, which had been investigated for other crops such as rubber, had yet to be asked or addressed in the case of coffee (Cramer, 1957, p. 1). Somehow this is still the case, in 2019.

Oppressors are defined by Freire (1972) as "those who deny personal autonomy of others by imposing a worldview paradigm onto the oppressed that denies them the power to direct their own lives" (p.1). By this definition, agricultural development that does not call on heavy participation of its target beneficiaries, in the development and dissemination of innovations designed to address their needs carries oppressive connotations. This does not have to be the case. The dynamic can be changed simply by asking questions, getting to know people, giving attention to context and nuance, and spending more time in areas where development occurs.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

In Conclusion

Farmer perception of the hybrids is a crucial component to their acceptance of them and ultimately affects the success of development projects such as this one. This chapter discusses recommendations of the author to development agents and agencies who aim to support smallholder coffee producers through the introduction of coffee hybrids. Some of this is transferable to other regions, and likely other crops, while some is specific to the Yepocapa region. Recommendations for future research attempt to address the question of transferability.

Recommendations for Future Research

Recommendations include replication of this study with smallholder coffee producers in other regions and countries. Replication will test transferability of the findings and identify non-transferable themes, which are likely also of interest in research and development. For instance, in areas where farmers do not already have a history of grafting their coffee, the grafted aspect of the hybrids may be an added barrier. And, if there has not been a recent public outcry against transgenic organisms in the country, hybrids being confused as GMOs and thus resisted is a less likely obstacle to adoption. Both these examples are likely but remain to be tested. investigating these would further amplify the efforts of the present study and add to the body of knowledge about obstacles faced by smallholder coffee farmers.

Further recommendations are to evaluate a similar project by comparing results to all five stages of the innovation-decision model, thus following intent to adopt through to adoption and confirmation. The present study evaluated intent to adopt by only collecting data for and comparing to the first two stages of the model. All five stages must be assessed in order to verify claims that, once demonstrated, the characteristics of the hybrids are convincing evidence of their advantage over outdated varieties, and thus increase adoption. Evaluating all five stages would also produce a more robust finding that Rogers innovation-decision model is a good model by which to evaluate smallholder adoption of disease resistant coffee hybrids.

True benefit of coffee hybrid implementation should be assessed by studying productivity, cost of production, potential and realized quality in the smallholder system, and value in the specialty market. As of the writing of this document, there was no plan for assessment of 'Centroamericano' productivity or cup quality in Yepocapa. Both of these evaluations are highly recommended. Yepocapa provides a case of size and proportion appropriate for this assessment, results of which can provide the basis of planning and evaluation in other cases. As it was showcased in the present study, the Yepocapa farmers provide heterogeneity in the form of multiple farming associations, which have hybrids of two different ages planted at elevations across a 1000-meter range. All of these aspects could support robust investigation. Additionally, as evaluations take place and new information is learned, farmers in Yepocapa could benefit from understanding how their field management practices affect quality and productivity, and how time-of-harvest and post-harvest handling affect flavor and cup

quality. Modifications to current strategies coming from these lessons can be assessed for impact on productivity and cup quality of the hybrids, and for their ultimate effect on profitability in the Yepocapa case.

Recommendations for Development Agents and Agencies

Careful listening throughout discussions with the Yepocapa coffee farmers and cooperative board members leads to the following recommendations for development agents.

Closely monitor any nursery that will be responsible for production of seedlings or plantlets. Quality of the product and timing of delivery can have a decided effect on perceptions of the newly introduced hybrid, which may affect interest in implementation. Negative perceptions may affect acceptance of similar technology in the future. Investigate cultural and political context regarding transgenics and other issues and tailor the introduction of hybrids such that a clear delineation is made. A cultural stance against transgenics may cause farmers to have negative preconceptions regarding grafted or hybrid technology. Additionally, care should be taken when delivering the message that farmers should not save/plant seeds from hybrid coffee. This should be accompanied with an explanation of how the hybrids are different than GMOs and the biological reasons why seedlings will not have the characteristics of the mother plant, at a level that is understandable to someone without a formal education.

Assess the level of education and work on that level to teach what the hybrids are, how they will be of benefit, and how they must be managed for optimal results.

Demonstrate the technology in a visible, tangible way within the community(ies) to which the hybrids will be introduced. Emphasis on demonstrating characteristics the farmers already seek in a variety, such as high yield or bean size, would be an effective method of approaching the introduction. This requires first making inquiries about what specific characteristics are most highly valued by the target communities.

Demonstrate, in detail, planting of the hybrids directly, to all who are given plantlets. Clear instructions, and especially witnessing the process in person, will reduce the potential of farmers planting without removing plastic bags or containers the plantlets are delivered in. This would also reduce the potential of other issues such as planting too shallow, leaving roots exposed, or planting too deeply, submerging the graft point below ground.

A well-rounded education targeting livelihood improvement would include lessons on coffee management for improved production, business planning and management, and coffee quality as it is assessed on the consumer end of the supply chain. Teaching record keeping would be a good place to start in regard to both coffee and business management.

If the project budget allows it, consider preparing and delivering plantlets in biodegradable bags. Biodegradable material may be more expensive than polyethylene but removes the possibility that plantlets or seedlings are planted in plastic bags. This is also a more environmentally friendly choice, as it reduces plastic waste generated by the project.

Provide both fertilizer and technical assistance to help manage newly given hybrids, with emphasis on nutrient application between the time of planting until the hybrids reach maturity, to reduce variability in management of the new plants.

Provide support for renovation of post-harvest processing and storage facilities. Cooperatives may be limited by their ability to transport, process, dry and store their coffee and thus, even if they produce more coffee through improved varieties, they may still be forced to sell through less profitable means, such as to *coyotes*, which will continue to restrict their income.

Due to its perennial nature, observability of any coffee variety's characteristics at maturity requires several years of establishment. Thus, it is recommended that projects aiming to support smallholders, who either do not have the resources to do their own trials, or who would take extreme risk in giving up those resources (even a small section of their healthiest plot of land), by setting trials on land outside of that which is owned by the smallholders in the project.

Provide an avenue of sale for the coffee once the hybrids mature and produce. A guaranteed market, even for a percentage of the crop, may mitigate fears that a new variety or hybrid of coffee will not sell. This may require the prior step of assisting the cooperative in obtaining a license to export.

It may be a much longer-ranging goal, but to truly empower and build capacity within smallholder coffee growing communities such as these six, their ability to act autonomously and make beneficial, long-ranging decisions, must be addressed through

debt reduction, land ownership, licensing for export, education in business and horticulture and better representation along the full supply chain.

On Evaluation

As a whole, in development, where people's lives are directly and substantially affected by interventions, and where the future of an important product like coffee hangs in the balance, the industry should assume the stance that assessment is a very important tool. During a conversation with one of The Starbucks Foundation's administrators overseeing initial stages of the SICFI project, the principal investigator was grateful when she was asked to share findings on project aspects that did not advance project goals, in tandem with those that did. According to this administrator, it is most helpful to them as a funding agency to know what can be improved on. Hearing "everything is going great" does not advance their organization's capabilities to target the needs of the people they aim to help, nor to support the future of the coffee industry.

The principal investigator is thankful to WCR for allowing the use of such participatory methods, as this is facilitated identification of true ways in which projects like the one in this case can be improved. With constant improvement, the funds and other resources put into these projects can be put to more effective ways of understanding the context in which a development intervention will take place, and in addressing the true needs of low resource and marginalized communities.

Importantly, much of the information collected in evaluation should come directly from those targeted by the development. This study did not employ ethnographic methods, but the concept that multiple perspectives around an event or concept exist

simultaneously, and that each one is valid, need not be ignored. Smallholder farmers face numerous obstacles that likely reduce confidence in their ideas, and in sharing their perspectives. Given this context, it is the responsibility of development agents and agencies to direct sufficient attention and resources to providing space where the target beneficiaries of their interventions can feel comfortable sharing their perspectives and experiences in detail.

It is preposterous to say that one cannot do research and development simultaneously. Evaluation is research and research is evaluation. It is the duty of development agents, who are often reliant on funds dedicated either by governments, aid agencies, or industry to evaluate their activities with the goal of improving them each time around. Taxpayers' dollars and earnest industry players who are not versed in scientific methods are reliant on the administrators of research and development to reach the goals of better understanding and functioning within natural, social and economic worlds. Constant and consistent evaluation is the only way to move the needle closer to a more equal situation between coffee farmers and consumers of their products, and to target efforts so they are effective, clear, non-intrusive, and helpful.

Final Note

Threats to coffee are threats to human culture. We do not need to "keep people in coffee," we need to keep *coffee* in coffee, by supporting its growth and development, and modifying approaches within the industry such that all parties are equally cognizant of, and invested in, methods of addressing the main issues compromising coffee's future.

Coffee offers a way to tangibly link people living in different parts of the world. It is an agricultural crop with its own set of issues due to having low genetic variation and being perennial, high altitude, and heavily dependent on rain patterns. Coffee also has more potential to create bridges and build economies than most other crops. It is hugely economically and culturally important to humans around the globe and throughout history. It is, in of itself, a direct line of communication. The producer who invests time and resources towards field management sends the results of these efforts to the consumer, who can taste them in the flavor profile of the cup; the consumer sends a message of appreciation in return by paying a good price.

Developing a truly inclusive supply chain is a way to treat the threats to coffee, which are numerous and looming, with the respect they deserve. This means bringing producers, of all sizes, to the discussion table about issues affecting logistics, cup quality, culture, and economics in consuming countries, as much as it means educating consumers on production issues. As development agents, who stand with one foot in the lands of production and one in the lands of consumption, it is our responsibility to reduce self-interest, to be curious about the truth instead of afraid of it, to consistently identify and reflect on our own biases, and to allow ourselves to be conduits of information. From the perspective of the principle investigator (Figure 34), the Yepocapa case reflects how seemingly insignificant details, histories, and perspectives can substantially impact outcomes, and that presentation and process in development intervention are as important as characteristics of the innovations introduced.

Figure 34. The principal investigator holding out a *reyna* graft. Photo credit: Daniel Dubón

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APPENDIX A

FOCUS GROUP QUESTIONS

Research questions have been developed using information gathered in informal discussions, had during previous visits to the project site as well as through discussions with the Promotores, other SICFI Project Personnel and members of the team at Anacafé and through peer-reviewed and contemporary literature review.

Questions

1. What are your biggest obstacles to producing and marketing high-quality coffee?
2. What do you do in response to these obstacles?
3. What would you be able to do differently if these obstacles were removed?
4. Does coffee production generate enough income to support your household?
5. If you could change one or two things about the current situation, what would those changes be?
6. What kinds of coffee do you grow? What characteristics do you look for or like most when choosing the variety?
7. Do you have any hybrids on your farm? If so, which ones do you have and where did they come from?
8. What is your opinion of the hybrids?
9. Has your opinion of the hybrids changed, or have you noticed a change in the opinion the community has about the hybrids at any point in time?
10. Have you noticed any changes in the weather in the last few years? If so, what changes have you noticed?
11. In what way are these changes (if they reported noticing any) affecting your ability to produce and market high-quality coffee?

12. Have you ever experienced or witnessed theft or vandalism on the farms? If so, what happened and when? Do you think it was related to any specific event, like the [aforementioned event]?

13. Have you known of any migration away from coffee production and/or the area, either to work seasonally for other farmers/larger fincas or migration out of the country as a result of issues in coffee?

14. Is there anything else you would like to tell us?

APPENDIX B

FOCUS GROUP PROCEDURES

Group 1

Procedure: Consent and exercises

Consent: Subjects will be asked to convene at 7:45am in the salon at the central meeting locations of each cooperative to be situated in time for the meetings to begin at 8am. Consent and an explanation of the purpose for the exercises will take place for the first 20 minutes, with the goal of beginning the exercises by 8:20am. Consent will be explained fully, in Spanish, to all participants prior to start of the focus groups. At this time, each participant will be given the opportunity to ask any questions and decide if they want to decline participation.

Introductions: Each person in the room will be given the opportunity to present themselves. Subjects will be asked to give their name and relationship to the cooperative. The research team will present themselves and their role in the SICFI project. Taya will take this opportunity to explain the purpose of the research and describe the mobility map and timeline exercises (Berg, 2000). It will be emphasized that the research team is there to learn about coffee production and sale as experienced by the participants.

Mobility map: The discussions will initiate with creation of the mobility map (60 minutes). A large blank piece of paper will be hung on the wall in front of the group with only the central meeting location noted on the page. Subjects will be asked to describe the locations they travel to on a regular basis for the purpose of coffee production or

sale, for what purpose they go there and what means of transportation they use when traveling to each place. Locations described by the subjects will be symbolized or written on colored post-it notes and positioned on the page as they actually exist in relation to one another and the central meeting location (where the focus groups are taking place). Group consensus must be achieved about the location of each marker before moving on to the next. By the end of the exercise a map will be created showing the community in relative distance to all locations regularly traveled to by the cooperative members, noting the mode of transportation normally used to get there. The Research Team will record responses to the research questions as they come up throughout the discussion and observations of subject participation will be made throughout the exercise.

Break: After the mobility map is complete the group will be given a ten-minute bathroom break.

Timeline: The timeline will be constructed next (60 min). Creation of the timeline will begin with the icebreaker question, "how did the cooperative get its name," (Narayanasamy, 2009) and from there subjects will be asked to describe the development of the cooperative from its establishment to the current state of affairs, including membership, what coffee varieties were commonly grown when, dates of past development and/or issues such as diseases affecting the coffee or technological advances in production, processing and/or marketing. Dates and events will be recorded on a blank timeline, starting with the date the organization was established and ending in the current season.

Break: After the timeline exercise, all will be given a fifteen-minute break, allowing subjects to use the restroom and stretch their legs and giving the Research Team time to discuss their observations and any need to further address specific research questions.

Discussion: The last hour will be spent in discussion with subjects, further investigating issues brought up in the Timeline and Mobility Map exercises, and asking any research questions that have not yet been addressed. Discussions will wrap up by 12pm and participants will go to lunch.

Schedule of events: Group 1

7:45am	Meet at Central meeting location
8am – 8:20am	Discussion about consent and the purpose of the day's exercises
8:20am – 9:20am	Mobility Map construction
9:20 - 9:30	Quick bathroom break
9:30am – 10:30am	Timeline construction
10:30am – 10:45am	Break, giving members time to stretch their legs and use the restroom and allowing the Research Team to discuss how things are going and which questions still need to be asked of subjects

10:45am – 12pm	Continued discussion of issues and events, including asking any questions from the previously constructed list which have not already been addressed in the previous conversations
12pm - 1pm	Lunch

Provisions for Group 1 subjects

The day will begin at 7:45am with pastries, tea and coffee provided to subjects and Research Team. Lunch will be provided to subjects at 12pm. after discussions and exercises have finished. Pastries, tea, plates, napkins and eating utensils will be brought from Antigua, coffee and lunch will be purchased from a local household.

Group 2

Procedure: Consent and Exercises

All cooperative members will be seated around one table or centralized area, depending on what is available at the location. Care will be taken that the Research Team is sitting at the same level as the subjects, either at the same table or in the same type of seating, to reduce any impression of interrogation. Each person in the room will be given the opportunity to present themselves. Subjects will be asked to give their name and relationship to the cooperative. The research team will present themselves and their role in the SICFI project. Taya Brown and describe her study and explain that the purpose of the meeting is to gain a comprehensive understanding of the experience of the farmers,

including establishment of the cooperative and any developments as well as any obstacles to production and marketing of high quality coffee. It will be explained that answers subjects give are totally confidential and that no one is keeping track of exactly who says what, but nonetheless subjects are not obligated to answer any of the questions if they become uncomfortable at any time. Discussion will initiate with a review of the timeline and mobility map which were created earlier that day and continue by asking the research questions. Care will be taken not to lead respondents to their answers, but to simply introduce questions from the list and ask further, more probing questions when necessary to elicit discussion. Daniel and Taya will moderate the discussion and the Promotores will act as observers.

Schedule of events: Group 2

1:45pm	Meet Cooperative Leaders at Central meeting location
2pm	Discussion about consent and the purpose of the day's exercises
2:20pm – 3pm	Discussion about timeline and mobility map
3pm – 4pm	Research questions discussed

Provisions for Group 2 subjects

The day will begin at 2pm with sandwiches and soft drinks provided to subjects and Research Team. Pastries, tea and coffee provided to subjects and Research Team towards the end of the meeting. Pastries, tea, plates, napkins and eating utensils will be brought from Antigua, coffee, soft drinks and sandwiches will be purchased from a local household.

Recruitment

Anacafé hired Juan Charuc, Wilson Ordoñez and Mario Turcios as Promotores for the SICFI project, to interact closely with the farmers who received the plantlets. Each Promotore is responsible for regularly keeping up with members of two of the cooperatives, including visits to the farms where the plantlets are being cultivated, and it will be through them that farmers will be notified of and invited to the focus groups.

APPENDIX C

OBSERVATION RUBRIC

Perception, Innovation and Coffee Leaf Rust Focus Group Observation Rubric *Cooperative:* *Location:* *Observer:* *Date:*			
Number of farmers present:	Ages:	Gender(s):	Relation to each other:

Observations during focus groups:

Social Interactions	
Who responds first?	What else do you notice?
Does everyone speak?	

Who speaks?	
Who does not speak?	

Topics of Discussion	
What, when, where, how, why?	What were the impact, result and response due to the event?
Coffee Leaf Rust	
Drought	

Climate Change	

What, when, where, how, why?	What were the impact, result and response due to the event?
Coffee Prices	
Varieties	

Coffee quality	

What, when, where, how, why?	What were the impact, result and response due to the event?
Other topics and/or themes:	Other impacts results, reactions: