ASSESSING RESILIENCE IN COFFEE DEPENDENT COMMUNITIES

OF HONDURAS, NICARAGUA AND HAITI

Lutheran World Relief
SUSTAINABLE DEVELOPMENT. LASTING PROMISE.

The University of Vermont
Agroecology and Rural Livelihoods Group (ARLG)

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1. ACKNOWLEDGEMENTS AND CITATION

1.1 ACKNOWLEDGEMENTS

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2. EXECUTIVE SUMMARY

The current scope and severity of challenges facing coffee smallholder farmers and farmworkers calls for a new perspective on how best to nurture meaningful and real positive change within these populations. Smallholder coffee producers tend to manage agroecosystems for subsistence production (e.g., maize), as well as local and global markets (e.g., coffee). The livelihoods of smallholder coffee farmers and workers are subject to multiple shocks and stressors that range from climatic stress to political unrest. For example, recent research on the impacts of climate change in Central America's coffee sector suggests that the region's producers face pressing challenges that not only affect coffee productivity, but also the viability of their livelihoods. Resilience is an increasing area of focus to address this, where a holistic approach encourages simultaneous attention toward land, people and markets. The aim of this study was to better understand vulnerabilities in coffee dependent communities of Central America and the Caribbean, and to contribute to strengthening resilience interventions and metrics in these contexts.

2.1 RESEARCH APPROACH AND CASE STUDIES

For this study, we used LWR's definition of resilience, as "the capacity of a system to absorb the impacts of shocks and stressors, to adapt to change, and to potentially transform, in a manner that enables the achievement of development results." Our research integrated concepts from the resilience literature, agroecology, the sustainable livelihoods framework and participatory action research (PAR). We examined three types of resilience capacities[1] including: 1) **absorptive**, 2) **adaptive** and/or 3) **transformative**, in response to **shocks** (perceived as *sudden*, unexpected, *events* that impact the system), and **stressors** (longer-term trends that undermine a system's performance). We used a mixed-methods approach, including surveys, focus groups and interviews, to examine qualitative and quantitative data from projects executed by local counter-parts in three countries.

The cases for this study included a diversity of partner organizations, as follows: 1) In **Honduras**, we worked with a project focused on diversification, food security and improved coffee production; 2) In **Nicaragua**, the project specifically focused on resilience aiming to integrate livelihood diversification, climate monitoring, and agricultural management to strengthen resilience capacities; and 3) In **Haiti**, the project targeted coffee renovation and income diversification to strengthen local capacity to respond to climate change, and building social capital in smallholder coffee cooperatives.

1. Key resilience capacities can be defined as follows: **absorptive capacity** – the ability of a system to prepare for, mitigate or prevent the impacts of negative events; **adaptive capacity** – the ability of a system to adjust, modify or change its characteristics and actions; and **transformative capacity** – the ability to create a fundamentally new social-ecological system.

2.2 KEY RESULTS

2.2.1 Shocks and stressors

Farmers reported drought and coffee leaf rust (*roya*) as the most severe shocks/stressors that they faced in the last three years. Most farmers also cited food insecurity as a constant stressor, although severity varied by country. In Honduras and Haiti, farmers were most concerned by drought and food insecurity; whereas *roya* was of highest concern in Nicaragua, where it was more frequently reported than drought.

2.2.2 Households Responses to Shocks and Stressors (i.e., coping strategies)

Farmers reported employing a series of **coping strategies** to respond to their challenges from drought, roya and food insecurity. Their responses were both related to and, in some cases, independent from project interventions. In Haiti, the overwhelming response to the identified shocks and stressors was 'we did nothing.' In both Nicaragua and Honduras, the majority of respondents felt that their coping mechanisms had left them in a better position. Farmers in all countries mentioned that they are taking the hits and attempting to stay afloat, but are also considering how they can adjust practices to get ahead.

Farmers also reported the **instability of coffee prices** as a consistent stressor. The impact of low prices is especially problematic for farmworkers, since their labor is considered an 'input' and when costs are being cut, their already low daily wages are at risk. In Honduras and Haiti respondents felt results were the same, regardless of their coping mechanism, which most often was working on incremental improvements in yield and quality. In Nicaragua, a slight majority felt their responses were leaving them better off.

Food security was also a pervasive stressor, for which responses included crop diversification, seeking credit/taking out loans, off-farm labor and rationing food, with these generally perceived as resulting in positive/neutral effects in Honduras and Nicaragua, and either neutral or negative for Haiti. Diversification was recognized as an important option for improving food security, but respondents mentioned that to realize improvements, requires significant investments of time, resources and a willingness to learn.

2.2.3 Effects of development interventions on resilience capacities

We assessed project efforts to increase resilience in coffee-dependent communities by categorizing interventions in terms of their absorptive, adaptive and/or transformative capacity. In all three countries, projects responded, either directly or indirectly, to the shocks and stressors identified as most severe by farmers (drought, roya and food insecurity). Most of the interventions implemented in the case studies resulted in the strengthening of adaptive capacities. While a few related to absorptive capacity, none explicitly focused on challenging power structures or systemic changes to support transformative capacities. The cellular information networks in Nicaragua are approaching transformative potential by supporting larger processes of co-learning, which could strengthen the agency of producers and cooperatives in the future.

2.2.4 Programmatic gaps and opportunities

Our analyses pointed toward four focus areas to strengthen resilience in coffee dependent communities: 1) Providing support for diversification strategies, including diversifying among varietals for established crops and leveraging social networks to connect producers with more reliable and/or lucrative markets; 2) Strengthening cooperatives and support organizations, which fill a niche for both connecting to market and technical assistance; 3) Building human capital, agency and trusting relationships, resulting in improved cooperation, communication, co-learning and innovation; and 4) Working toward greater equity, acknowledging co-dependence along the supply chain and identifying mutually beneficial options.

2.3 LESSONS LEARNED

Resilience theory discusses the idea of path dependency and past being the best predictors of future. Climate models and monitoring activities represent one example of this – where with intentional planning and data that is regional, instead of from a single plot, coffee farmers can adjust their practices and make informed decisions about the future suitability of their land. This improved ability to act, based on lessons learned, speaks to the value of investment in skills building and knowledge sharing that LWR is pursuing. Several important lessons emerged from the literature review and fieldwork associated with this study, as follows: 1) It is critical to conceptualize resilience and theory of change for actors to embrace the approach; doing this requires answering the questions of 'resilience for whom, to what, and in whose interest?; 2) The farm and surrounding landscape need to be seen and managed as interrelated ecological systems, in order to support farm and community resilience; 3) Context and relationships at multiple scales are vital to systems-level resilience. Resilience requires that systemic (and structural) issues be addressed even as individuals are wrestling with their own resilience capacities at the local level.

2.4 RECOMMENDATIONS FOR FUTURE RESILIENCE WORK IN COFFEE COMMUNITIES

Increasing resilience in coffee-dependent communities is critical to national economies, broader regional and national environmental conservation, as well as strengthening the livelihoods of smallholder producers. This requires: 1) investing and committing to long-term processes, rather than short-term projects; 2) an integrated approach to diversification (focused on diminishing risk and building both skills and agency); and 3) Monitoring and evaluation approaches, which include identifying emergent properties and a constant openness to adapting and adjusting course as conditions change.

3. INTRODUCTION AND CONTEXT: GENERAL RESILIENCE SITUATION FOR SMALLHOLDER COFFEE FARMERS IN MESOAMERICA AND THE CARIBBEAN

Smallholder coffee producers represent the largest sector of an approximate total of 14 to 25 million coffee farmers globally (Jha et al., 2014). These producers live in complex and dynamic ecological, social, economic and political realities. Multiple factors influence management approaches at the farm (agroecosystem) and landscape (ecosystem) scales (Gliessman et al., 2007). In Mesoamerica, smallholder coffee farmers tend to manage their agroecosystems for both subsistence production, as well as for local and global markets (Avelino et al., 2012; Isakson, 2009; Jaffee, 2007; Martínez-Torres, 2005). This results in a diversity of crops and distinct agroecosystems stewarded by these farmers (Méndez et al., 2010).

The livelihoods of smallholder coffee farmers and agricultural workers depend heavily on crops that are subject to multiple shocks and stressors related to market access, price fluctuations, supply chain constraints, pest outbreaks, climatic disasters, socio-economic and political conditions. A growing body of research on the impacts of climate change in Central America's coffee sector suggests that the region's producers face challenges that affect not only the productivity and quality of their crops (e.g., coffee leaf rust or roya and coffee borer, extreme events, changing seasonality, water availability) (Magrath, 2014), but also the future viability of their livelihoods (e.g., projected changes in suitability for producing arabica coffee)(Läderach et al., 2010).

In Mesoamerica, maximum and mean temperatures are expected to increase by 2° Celsius, which would potentially move the suitable Arabica coffee altitude range from 400-2000 masl to 800-2500 masl. Agronomic practices and water management will need to be adapted given these climate change projections. Countries without high mountains will likely experience the strongest effects of these higher temperatures, with greatest impact predicted for Nicaragua and El Salvador (Ovalle-Rivera et al., 2015). Though most of these climate predictions are looking 30-50 years into the future, coffee producers are already feeling the effects of the forecasted changes. The 2015/16 El Niño cycle is a case in point, causing disruptions that lived up to its 'Godzilla' reputation. A recent study analyzing pricing data from the International Coffee Organization (ICO), for the period 1989-2010, revealed a negative effect from el Niño on Arabica coffees prices (Ubilava, 2012). United Nations officials have attributed a global food crisis to impacts from the 2015/16 el Niño, asserting that "In Central America, El Niño conditions…led to a second consecutive year of drought – one of the region's most severe in history"(Vidal, 2016).

The current scope and severity of challenges facing coffee dependent communities calls for a new perspective on how best to nurture meaningful and real change within these populations, so that smallholder coffee farmers and farmworkers can thrive. Recently, a flurry of activity has focused on the concept of resilience. This follows nearly a decade of increasing attention from scholars, development practitioners and policy makers. Of special interest to these actors are: 1) the need to clarify the meaning of the term; 2) how to apply this approach and its implications for development practice; and 3) determining accurate assessment metrics. While there is still no consensus on best practices for resilience interventions, answering both 'resilience for who?' and 'resilience to what?' is a critical first step for providing a frame to what can be an ambitious and somewhat amorphous task. This publication seeks to address these issues and is specifically directed to development practitioners, researchers, policy makers and coffee industry actors that work with smallholder coffee farmers.

This study was designed to better understand vulnerabilities in coffee dependent communities, and to examine and contribute to strengthening resilience interventions and metrics in these contexts. Within this broader objective we placed a special emphasis on household and community resilience to climate change, food insecurity, and coffee price/market volatility. Case study sites were selected to represent both projects that were explicitly designed with a focus on resilience, and others that are adjusting current activities toward this end (Figure 1). The target populations were smallholder farmers, including both coffee producers and laborers on large estates, which were participating in projects funded and supported by Lutheran World Relieve (LWR). The projects were executed through different types of national and local-level NGOs, with varying levels of collaboration from outside partners. Exploring resilience dynamics within three distinct environments and executed by independent local partners provided an opportunity for identifying characteristics that are unique to place, while a regional focus in Latin America supports comparison across sites to identify more generalizable trends and recommendations that are more broadly applicable. As such, guiding questions for this research included: 1) What challenges are these households and communities facing (i.e., what main categories of shocks and stresses do they identify)?; 2) What resources can and do they draw on (i.e., what are the strengths and vulnerabilities of these smallholder farmer households)?; 3) How are they currently responding to shocks and stresses (i.e., what are their coping strategies)? and 4) How are LWR projects changing/improving their resilience capacities? In this study, we used a definition recently proposed by LWR, which refers to resilience as "the capacity of a system (e.g., a community) to absorb the impacts of shocks and stressors, to adapt to change, and to potentially transform, in a manner that enables the achievement of development results (e.g., sustainable livelihoods, well-being, poverty alleviation)" (Ospina, 2015)

Figure 1. Location of study sites

4. CONCEPTUAL APPROACH

Smallholder coffee producers represent the largest sector of an approximate total of 14 to 25 million coffee farmers globally (Jha et al., 2014). These producers live in complex and dynamic ecological, social, economic and political realities. Multiple factors influence management approaches at the farm (agroecosystem) and landscape (ecosystem) scales (Gliessman et al., 2007). In Mesoamerica, smallholder coffee farmers tend to manage their agroecosystems for both subsistence production and well as for local and global markets (Avelino et al., 2012; Isakson, 2009; Jaffee, 2007; Martínez-Torres, 2005). This results in a diversity of crops and distinct agroecosystems stewarded by these farmers (Méndez et al., 2010).

In response to a need for evidence-based research and methodological approaches that could be adopted/adapted by international development organizations, we began this study with a survey of existing resilience frameworks. We reviewed previous studies linking the concept of resilience and coffee growing communities and sought out ways to weave together the threads of Agroecology, the Sustainable Livelihoods Framework and principles from Participatory Action Research (PAR), as part of the study design. A brief overview of each of these topics follows, and a table summarizing their relevance to this study can be found at the close of this section. To gather contextual data for each of the three case study sites, we also undertook a desk review looking specifically at climate trends/extreme weather events, political environment and market trends for coffee price and staple foods, with the goal of identifying key internal and external factors impacting stability for these populations. The desk review included project-specific documents for each of the three case study sites, including project proposals, baselines and monitoring and evaluation reports.

4.1 RESILIENCE FRAMEWORKS

From a development perspective, a resilience approach signals an intention to not only maximize benefits to communities, to also increase the potential return on investment that has been associated with more holistic and preventative interventions. As highlighted in Frankenberger et al. (2014 p. 1): “The call for a shift in aid architecture toward greater support for longer-term initiatives to build resilience capacity has been fueled by studies demonstrating that the cost of immediate damage to life and property, coupled with the resources spent on emergency response, can be several times greater than effective disaster risk management and development programming”.

In our search for practical, actionable resilience frameworks, we encountered an incredible wealth of examples – some of which focus on theory, others on measurement indicators, and others on step-by-step implementation guides to promote on-the-ground application. Because many of the approaches are not specifically relevant to the population of smallholder farmers and laborers who are the focus of the current research and/or are highly conceptual, we decided to review frameworks that: 1) were frequently cited (as a proxy for perceived quality); 2) lent themselves to direct application; 3) contained aspects relevant to smallholder coffee

producers; and/or 4) included a sustainable livelihoods or related framework (defined further in this section). Given questions of agency and inequity within the coffee supply chain, we also sought resilience frameworks that provided guidance on how to assess/address issues of power and justice. In the following sub-sections, we discuss five key approaches that were selected as highly relevant and current to assess resilience in coffee communities of Latin America and the Caribbean.

4.1.1 Absorptive, Adaptive and Transformative Capacities

Following early resilience theory from the field of ecology (Folke et al., 2002) and its application for development studies (Béné et al., 2012; Frankenberger et al., 2014), resilience can be divided into three types of capacities in response to shocks and stressors: the capacity to absorb, adapt and/or transform. In this context, shocks are perceived as *sudden*, many times unexpected, *events* that impact the system and can have short or long-term repercussions; stressors, on the other hand, are longer-term *trends* that undermine a system's performance and may increase its vulnerability (Ospina, 2015). Each of these capacities is described briefly below:

Absorptive capacity – the ability of a system to prepare for, mitigate or prevent the impacts of negative events using predetermined coping responses in order to preserve and restore essential basic structures and functions (Béné et al., 2012; Cutter et al., 2008; Mitchell, 2013; UNISDR, 2009).

Adaptive capacity – the ability of a system to adjust, modify or change its characteristics and actions to moderate potential, future damage and to take advantage of opportunities, all in order to continue functioning without major qualitative changes in function or structural identity (Béné et al., 2012; IPCC, 2014; Mitchell, 2013).

Transformative capacity – the ability to create a fundamentally new social-ecological system when ecological, political, social, or economic conditions make the existing system untenable (Folke, 2006)

4.1.2 Role of Initial Asset Allocation and Stability

At all scales, what individuals, households and communities choose and are able to do depends greatly on their available portfolio of resources. "Accumulation, but arguably also optimal allocation of resources, requires a certain degree of stability (or some ability to buffer shock)" (Béné et al., 2012 p. 24). When all resources and efforts are being directed toward surviving, it is not likely that the groundwork is being laid for transformative change. This idea becomes important when considering resilience interventions and accounting for a baseline position of project beneficiaries. A nuanced but critical factor to include in this initial assessment (and in subsequent project monitoring activities) is the current load that is being managed by these individuals/households. This 'load' is often considered through an inventory of activities, but should also account for associated mental burdens (both analytical and emotional) and the level of effort that is expended.

The calculation of available time and attention is sometimes called 'bandwidth' (meaning energetic or mental capacity) and is accompanied by the idea of slack – identifying whether there is any space within the current system for change, or whether adjustments to status quo would require a trade-off (Mullainathan and Shafir, 2014).

4.1.3 Resilience or Vulnerability Pathways

In addition to assessing resources and vulnerabilities during 'normal' periods, resilience theory focuses on the impact of responding to shocks and stressors. There is often an implicit positive association with resilience, despite the fact that resilience is not by definition associated with beneficial outcomes (Béne et al., 2012). An example of this idea is a tenacious street dog that confronts and survives daily assaults, but - while technically resilient - is still down and out. Therefore, a critical distinction is whether responses to shocks and stresses move individuals, households, and/or communities into positions where they are better or worse off. Another way of framing this is to describe responses to disturbances, or coping mechanisms, as having potentially erosive (negative) or non-erosive (neutral or positive) consequences. Some coping strategies may risk diminishing stocks, which could leave individuals and communities worse off (e.g., taking out a loan at a very high interest rate and then falling further into debt when unable to pay it back), leading to what some describe as a *vulnerability pathway*. The alternative, where coping strategies leave the individual or community better off, can be described as *resilience pathways* (e.g., community savings groups that provide short-term loans at low- or no-interest). The eventual trajectory of a resilience pathway may lead out of poverty, while the alternative vulnerability pathway reinforces problems typical to poverty traps (Pasteur, 2011).

4.2 SUSTAINABLE LIVELIHOODS FRAMEWORK AND RESILIENCE

The livelihoods concept evolved in the early 1990s out of a need to understand, from a multidisciplinary perspective, the many and distinct ways in which people make a living; and in order to better guide development interventions designed to alleviate poverty and improve livelihoods (Bebbington, 1999; Chambers and Conway, 1992; Ellis, 2000; Scoones, 1998). The livelihoods approach represented a practical critique to income-based definitions of poverty and recognized the need for integrated sustainable development approaches. The livelihoods framework is an analytical tool, which aims to contextualize the complexities of rural livelihoods as well as a prescriptive tool to identify areas of need and appropriate opportunities for development interventions. Within the sustainable livelihoods framework, a household's livelihood portfolio is made up of natural, physical, social, economic and human assets or capitals. As the concept has evolved other assets have been added, such as cultural and political, among others (Gutierrez-Montes et al., 2009). Access and management of these assets is affected by issues of power, agency and equality, which are influenced by social relations (i.e., gender, class, age, ethnicity), institutions (rules and norms, land tenure), and organizations (NGOs, cooperatives, government institutions) (Ellis, 2000).

One of the critiques leveraged by those who advocate for a resilience approach is that the livelihoods framework focuses on vulnerabilities, which is one of the critiques leveraged by those who advocate for a resilience approach. However, there are implicit connections linking an

individual/household's capacities, assets, and agency to the ability to cope, adapt, mitigate or transform. Donovan and Poole (2014) used the livelihood framework to analyze the interactions between different assets, with special emphasis on access to markets in Nicaragua. Their results suggest the importance of having access to different assets over time (i.e., natural, social, financial, etc.), since those households having higher assets levels for longer periods are those who usually take best advantage of new development interventions. This aligns with the previously mentioned concepts of bandwidth and slack. Households are constantly making calculations on whether investing in one asset category will be at the benefit or expense of another. This in turn raises questions about how to best design interventions for the most vulnerable populations.

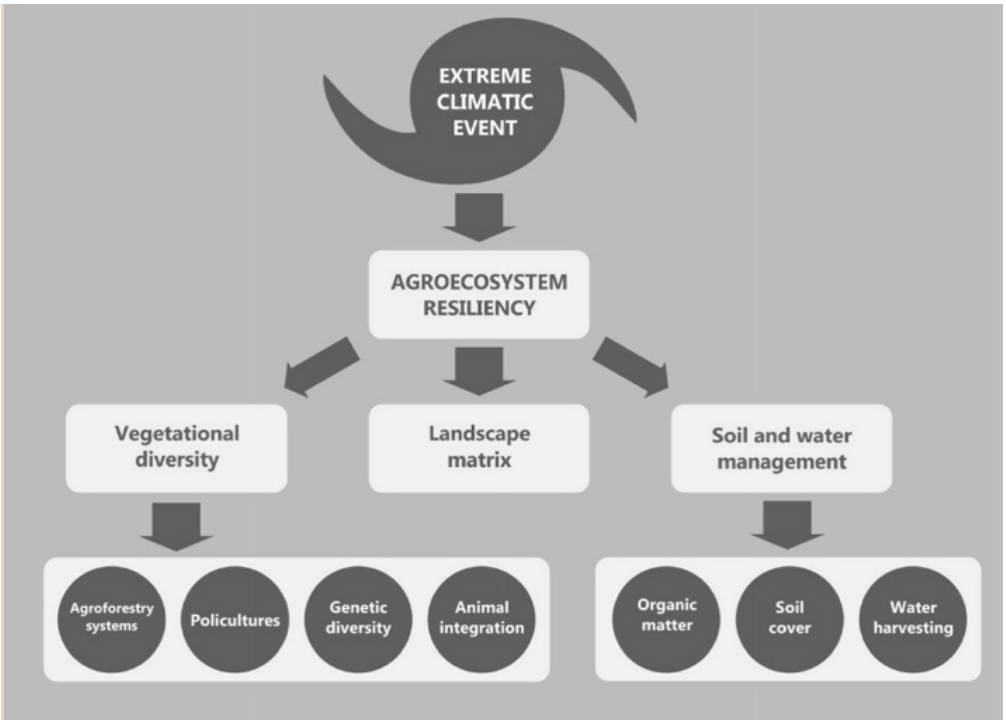
According to Plummer and Armitage (2007) people with resilient livelihoods can cope, mitigate and adapt to shocks and stress, can maintain or improve their existing asset base, and can guarantee a reproduction of a sustainable living for the future. In line with the vulnerability/resilience pathways described above, Titonell (2014) created typologies based on strategies and livelihood contexts, based on the following three 'regimes': 1) hanging in; 2) stepping up; and 3) stepping out, which were adapted from Dorward (2009). From this perspective, those with the lowest initial asset allocations most often remain in precarious situations that do not allow them to move toward a state of greater resiliency. Those who have the possibility of improving their situation from new activities and/or investments have an opportunity to 'step up', while those who manage to stabilize their assets (often through a combination of maintaining agricultural production, but also diversifying into non-agricultural products) have the greatest likelihood of 'stepping out' or escaping the constraints of poverty.

4.3 AGROECOLOGY AND RESILIENCE

Engaging resilience as a theme requires constant refining of the relationship between individuals and systems. Agroecology can be defined as an approach that integrates ecological science with other scientific disciplines (e.g., social sciences) and knowledge systems (e.g., local, indigenous) to guide research and actions towards the sustainable transformation of our current agrifood system (Méndez, 2016). Agroecology is a means for analyzing agricultural strategies and management practices in relation to natural resources, considering not only ecological impacts but also their implications for social, political and economic factors. Agroecology focuses on the complexity of socio-ecological systems by first identifying the parts of the system separately and then working to understand and visualize how these components interact as part of a larger system. One of the first uses of the concept of resilience in agroecological research was a comparison of the impacts of hurricane Mitch in Central America, where its effects were compared between farmers using agroecological and conventional practices (Holt-Gimenez, 2002). Biophysical and financial indicators were used to assess if and how agroecological practices had contributed to resilience in the face of this storm. In this analysis, agroecological producers were able to better withstand the impacts of Mitch, and were therefore less vulnerable.

Following Holt-Gimenez' work and with ever increasing attention on climate change, more researchers are exploring the application of an agroecological approach to climate change and resilience. The agroecological approach has maintained a strongly ecological perspective with regard to resilience (Figure 2), although in recent years several publications also include a perspective relating to social systems, from a socio-ecological perspective.

Figure 2. Agroecological framework for the study of resilience and climate change, and focused on ecological factors of the landscape (Source: Altieri and Koohafkan, 2013).



For this study, we focused on two aspects of agroecology, including: 1) the condition or 'health' of the natural resource base of the agroecosystems studied; and 2) the management practices, linked to agroecological principles that are being implemented in the farming systems being managed. In Appendix 1 we present results from a recent review outlining links between indicators of resilience and agroecological practices in smallholder coffee farming systems. Key results from this review point towards the ecological importance of using diversified shade for coffee plantation management and crop diversification, for food and the market, as a food security strategy. These findings provide information about specific practices that can support resilience, including a variety of livelihood factors, such as natural, financial, social and human assets. It supports our arguments for the need to elucidate links between the different assets in order to better understand 'whole system' resilience for a household and its farming systems, as well as a broader landscape and community.

In addition, Gliessman (2015) has proposed an agroecosystem transition framework (from industrialized agriculture to sustainable food systems), which can be adapted to link agroecological and resilience pathways (Table 1). This agroecological framework follows a series of steps that have been observed when farming systems seek transformation to more agroecological options. The first three steps occur at the farm level, beginning with absorptive and adaptive adjustments. Starting on the third level of transition, the transformative nature of the changes begins at the farm, calling for a deeper redesign of farm components in order

to restore and strengthen ecological processes. All of these changes also require adaptation and change in other livelihood assets, such as social, financial and physical, in much the same way as working towards increased resilience. The last two levels expand beyond the farm to engage with consumers, decision makers and other relevant actors, in order to 'redesign' the entire food system. Along the same lines, strengthening the resilience of marginalized smallholder farmers may require a deeper global transformation at the food system level, rather than exclusively within the farm and the landscape.

Table 1. Adaptation of Gliessman's (2015) agroecological conversion levels to include a resilience dimension.

Conversion/Transition Level	Scale	Farmer Practice & Collaboration	Social Change	Resilience Dimension
1. Increase efficiency of industrial practices	Farm	*Important*- lowers costs & lessens environmental impact	*Minor*	*Absorptive*
2. Substitute alternative practices & inputs	Farm	*Important*- supports shift to alternative practices	*Minor*	*Adaptive*
3. Redesign whole agroecosystems	Farm, region	*Important*- builds true sustainability at the farm scale	*Important*- builds enterprise viability & societal support	*Transformative*
4. Reestablish connection between growers & eaters; develop alternative food networks	Local, regional, national	*Important*- forms direct and supportive relationships	*Primary*- Economies restructured; values & behaviors changes	*Transformative*
5. Rebuild the global food systems so that it is sustainable & equitable for all	World	*Important*- offers the practical basis for the paradigm shift	*Primary*- World systems fundamentally transformed	*Transformative*

4.4 PARTICIPATORY ACTION RESEARCH (PAR)

Participatory action research (PAR) can be defined as an approach that brings together research and non-research actors in an iterative process of research, reflection and action (Bacon, 2005). PAR usually evolves as a negotiated, long-term process and researchers accompany non-researchers (e.g., communities) to accomplish tangible outcomes (Méndez et al., 2013). PAR offers a practical methodology for bringing forward the expertise of non-researchers – including small-holder farmers and others who have deep knowledge of place, content and practices- to define research questions in partnership with those who have been trained more formally in research and experimental design. Ideally, the result of this collaborative work is knowledge that has been co-created and that is actionable. The research team for this project has used this approach in resilience relevant work with coffee communities in Nicaragua and several types of farmers in Vermont, U.S.A. (Méndez et al., 2016). Although PAR can be a challenging process given its need for transparency, accountability, trust and longer-term timeframes, it also matches many recommendations associated with resilience work that emphasize the importance of longer-term partnerships, capacity building, and the critical role of observing emergent properties, and following cycles that build on previous learnings/development. PAR also offers the potential to fully integrate monitoring and evaluation to actions that are informed by research.

4.5 SYNTHESIS FOR AN INTEGRATED APPROACH TO RESILIENCE

In the above sections we presented concepts from a variety of theoretical frameworks. Our integrated resilience assessment framework draws heavily from the field of agroecology, as we believe it has been somewhat absent in the evolution of resilient thinking, but offers interesting opportunities to advance the field. Table 2. presents the key frameworks that have informed this study and the rationale behind their use.

Table 2. Core concepts proposed for an integrated resilience assessment framework.

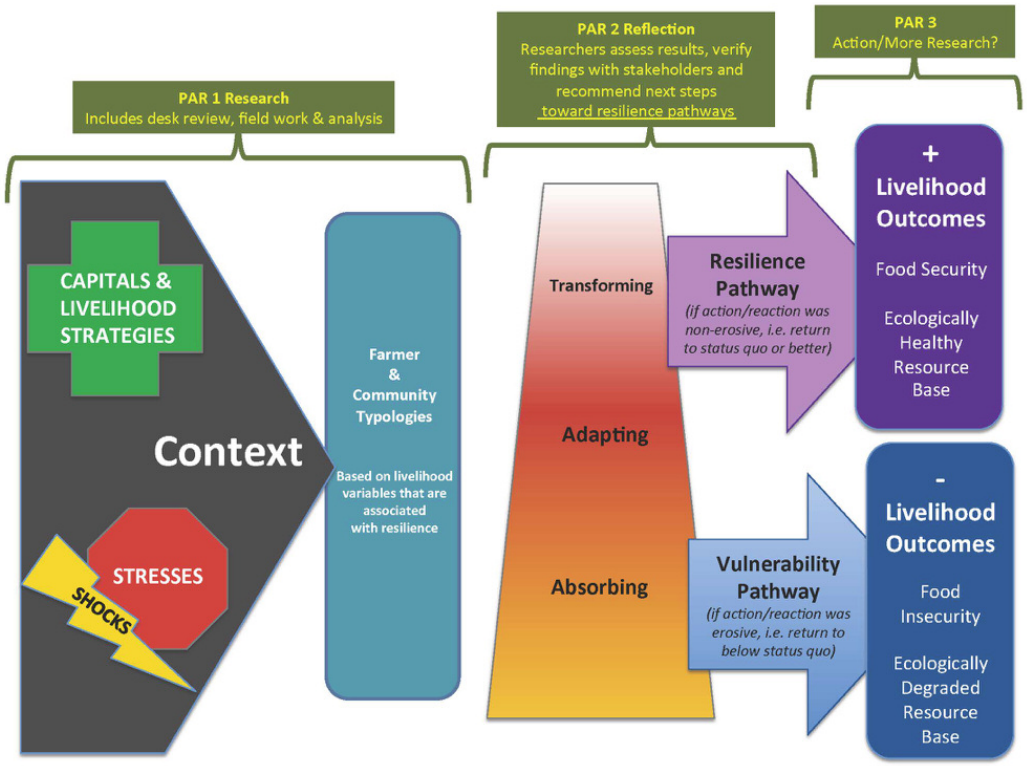
Core Conceptual Frameworks	Relevance for Resilience Interventions in Coffee-dependent Communities
Resilience theory/frameworks – articulate what factors set resilience interventions apart from other development efforts (e.g., focus on capacities and pathways, holistic approaches and multiple time scales, etc.)	■ Importance of determining working definition of resilience to then facilitate design of interventions that will build desired capacities that lead toward resilience pathways (conceptualization of resilience should inform the theory of change of a project or program). ■ Categorizing development interventions as protective, preventative, promotive and/or transformative allows for a more realistic assessment of the resilience potential of proposed project activities. The potential for sequential ordering to nurture the development of resilience capacities and leveraging positive momentum, challenges the more traditional 'project' model that expects quick and easily demonstrable returns.
Livelihoods approach – informs understanding of asset allocation and stability, supports consideration of tradeoffs and interactions	Determining both the actual and perceived resource levels within households, organizations, communities, and regions is critical to designing effective interventions. Human and social assets are critical for resilience work, even if topical focus is on agricultural production.
Agroecology – based on principles such as conserving resources, managing ecological relationships, maximizing long-term benefit and prioritizing people's empowerment, also includes sub-principles and recommendations for practices adaptable to context	■ Providing a strong ecological basis to analyze resilience baselines and assessments, with a focus on ecological processes of agricultural systems. ■ Utilizing a systems approach, with a focus on interactions among human, agroecosystem and broader landscape components.

5. RESEARCH APPROACH

In this section we present an overview of how we linked the concepts presented in Section 4 to the specific research methods detailed in Section 6. Our case study methodology was framed as a mixed-methods approach, collecting and analyzing both qualitative and quantitative data. Case study methods bring together a variety of sources of empirical information to analyze contemporary 'real-world contexts', with a desire to explain (the how and/or why) of a particular phenomenon (Yin, 2014). Yin (2014) proposed that case studies will usually contain more explanatory variables, rather than data points, and rely on source triangulation to validate and undertake a deeper examination of factors. The case study approach aligns well with our mixed-methods approach and also aided comparisons across the three different sites, and we investigated the same phenomena in three distinct contexts.

Figure 3 provides a schematic representation of our research approach through three phases that seek to follow the phases of participatory action research (PAR). However, given the short time available for this study, we were unable to fully engage in a PAR process. Instead, we used PAR as a guiding principle for all of our activities, and will explore the possibility of future work that would allow for a deeper engagement, which is more in-line with a PAR process.

Figure 3. Schematic representation of our research approach
(Adapted from Frankenberger, et. al 2014; Pasteur, 2011 y Béné, et. al 2012).



5.1 RESOURCE PORTFOLIO OF INDIVIDUALS, HOUSEHOLDS AND/OR COMMUNITIES

In line with the livelihoods framework, we assessed five asset categories (natural, human, social, physical and financial) to design our data collection instruments. Because resilience is not static, collecting data for only one period meant capturing only a snapshot of resource allocation levels. For a resilience analysis, these initial states or 'baselines' must be considered in relation to "...subsequent-state measures (well-being outcomes), disturbance measures (shocks and stresses), and capacity measures." (Frankenberger et al., 2014 p. vii). We conducted interviews, surveys and focus groups (each described in more detail below) to gather current levels of resource allocation by category, which served to evaluate the relationships among resources, resilience capacities, and interventions for this particular timeframe, and across the different cases and contexts. This snapshot can also provide data that can be used as a baseline for future evaluation.

To avoid the pitfall of valuing resilience capacities that rely on negative coping strategies, we followed the recommendation by the Resilience Measurement Technical Working Group of the Food Security Information Network, that "resilience is a capacity that should be indexed to a given development outcome (e.g., food security, poverty, health) with a normative threshold... the outcome of interest should include a normative boundary that defines a threshold condition below which the well-being of an individual, household or community is unacceptable" (Constas, 2014) p. 7). We selected two proxy resilience outcomes that relate to household and agroecosystem productivity and well-being; namely food security status (measured through the Months of Adequate Household Food Provisioning or MAHFP), and health of ecosystems (assessed through a variety of indicators, including plant diversity estimates and perceptions of soil quality).

5.2 ASSESSMENT OF PATTERNS IN RESILIENCE CAPACITIES

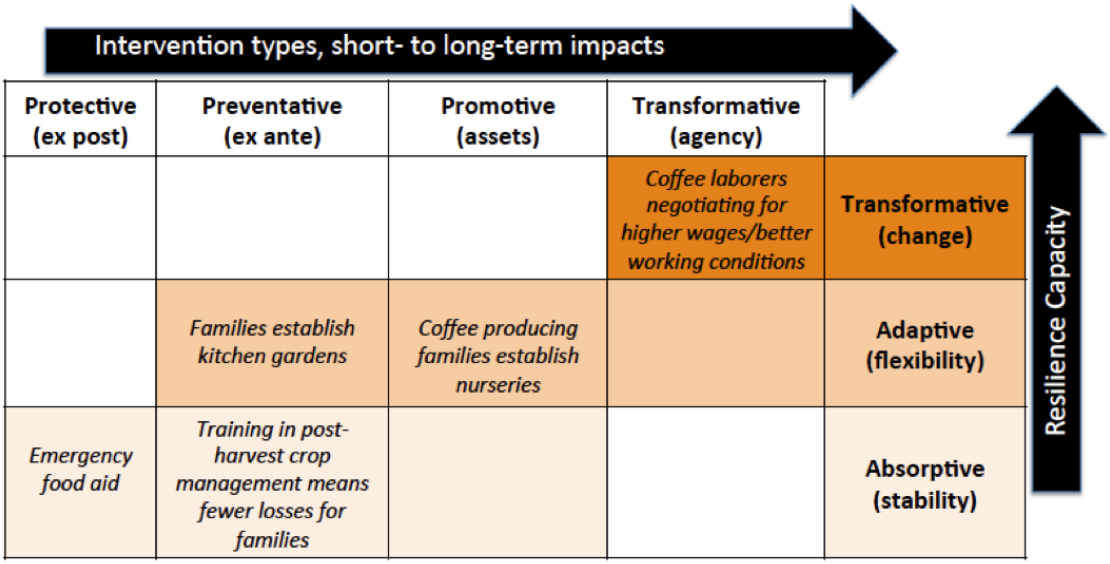
Establishing resilience status and trajectory seeks to determine whether individual responses (coping strategies/post-shock pathways) compromise long term prospects (UNDP, 2013) and/or whether individuals/groups have managed to 'strengthen their resilience but only at the detriment of their own well-being or self-esteem' (Béné et al., 2012). We used scenario/recall questions within the survey to determine whether post-disturbance responses fell under one predominant category or were spread across all three (absorb, adapt, transform), and whether individuals see themselves as being better, equally, or worse off as a result of their response(s). Following the recommendations of Constas et al., (2014), we combined qualitative and quantitative data in order to "...understand resilience capacity and map its origins and influences." (Constas et al., 2014 p. 9) For this, we used data from surveys, interviews and focus groups to create typologies in order to discern contributing factors that allow some individuals, households and/or communities to respond to disturbances in non-erosive ways (resilience pathways) while others suffer eroding consequences (vulnerability pathways).

5.3 CATEGORIZING DEVELOPMENT INTERVENTIONS IN THE CONTEXT OF RESILIENCE

Because interventions designed to improve resilience capacities within communities will likely cross several thematic areas, span various time horizons and ideally engage multiple stakeholders, a clearly articulated theory of change is critical for maintaining a 'true north'. A "…theory of change that correctly identifies appropriate leverage points…to effect desired change… depends on a thorough multi-hazard, multisector assessment of all the contextual factors that affect the system(s) under study." (Frankenberger et al., 2014 p. 7) This initial assessment should both serve to **assess resilience capacity** and **determine desired impact**.

Once the baseline status is determined and the theory of change articulated, then the development organization can **select interventions** and use M&E to **assess direction and rate of change**. Positive, maintained changes indicate potential for more ambitious/longer term interventions. As opposed to the resilience *capacities* outlined earlier in this document, which refer to the resilience capabilities of individuals, communities, regions, etc., in this section we discuss different resilience *categories* for development interventions, with examples relevant to the target population(s) (Figure 4). In other words, these terms describe the nature of specific actions, as viewed from a resilience perspective. These categories have been defined as: 1) **protective** measures (providing relief from deprivation), tend to be ex-post, or based on historical information; 2) **preventative** measures (seeking to avert deprivation and deal directly with poverty alleviation) tend to be planned 'ex-ante' or before a shock or stress occurs; 3) **promotive** measures (aiming to enhance assets, such as incomes and capabilities); and/or 4) **transformative** measures (seeking to address concerns of social equity and exclusion). Relating these categories to vulnerability assessments and resilience typologies provides a basis for considering both programmatic gaps and opportunities (Béné, 2012).

Figure 4. Categorizing development interventions in the context of resilience.



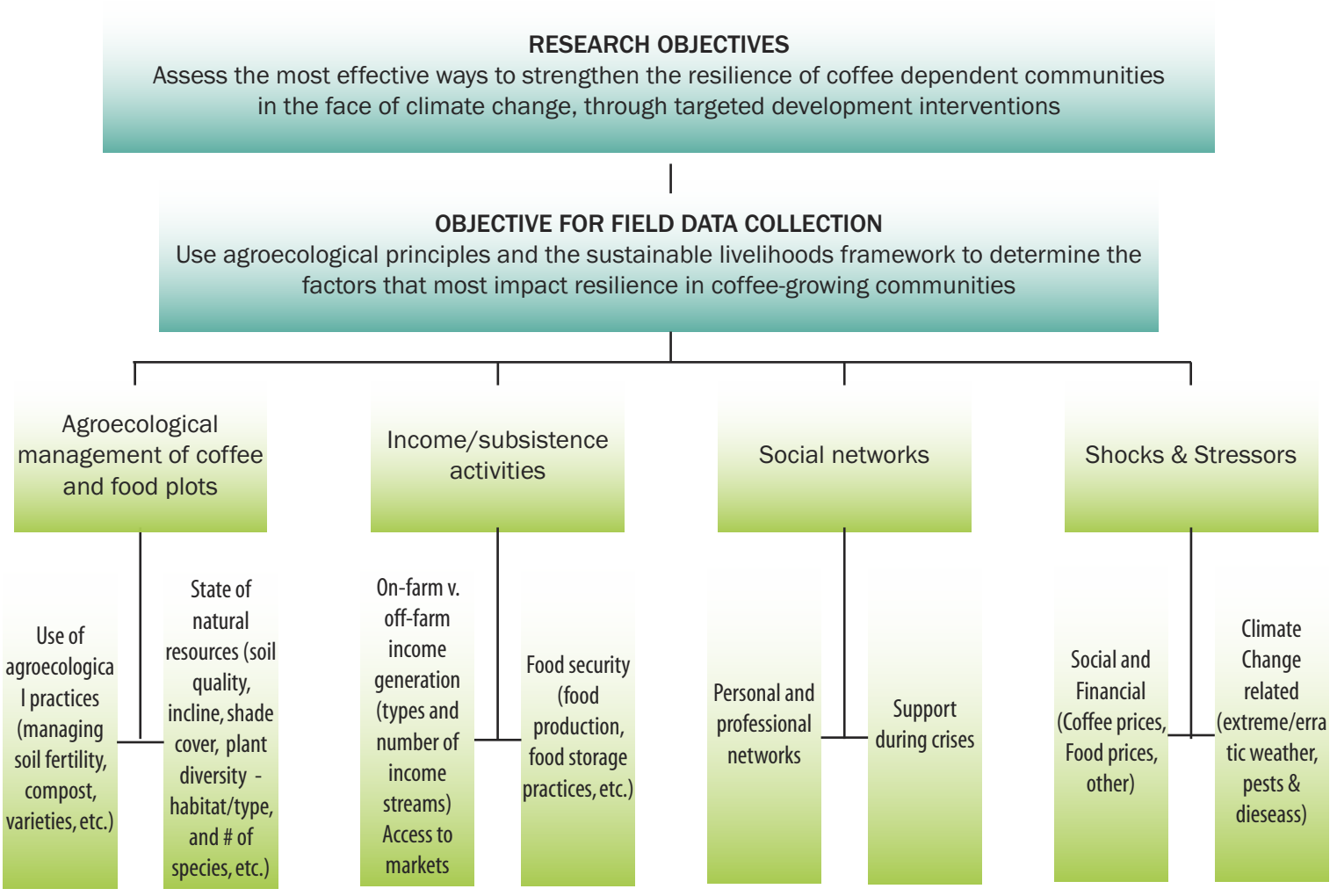
Adapted from Béné, 2012

Ideally, levels of resilience will increase through "...a holistic approach that integrates and implements a variety of interventions... (Using a) ...sequential and incremental approach." (Béné, 2012 p. 42) By observing the interactions among intervention types and developing (or decreasing) resilience capacities, development organizations can consider the ordering of activities or adjust their plans based on observed/emergent factors.

5.4 RESULTS FRAMEWORK FOR FIELD DATA COLLECTION

In Figure 5 we present a schematic diagram of our research results framework, which starts with the general research objective and follows through to indicators, which were obtained through multiple instruments described in further detail below.

Figure 5. Research results framework for assessing resilience in coffee-dependent communities.



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SUSTAINABLE DEVELOPMENT. LASTING PROMISE.

The University of Vermont
Agroecology and Rural Livelihoods Group (ARLG)

6. METHODS FOR CASE STUDY DATA COLLECTION

6.1 KEY ACTOR INTERVIEWS

We conducted interviews with key stakeholders in each of the three case study sites. These conversations provided important perspectives regarding the vulnerabilities and opportunities for the target populations. Interviewees were selected using a convenience sample, including actors who had direct connection to the project, either implementing organizations (farmer organizations, NGOs, etc.) and/or close collaborators (supply chain partners, government representatives, etc.). We also pursued conversations with leaders within the coffee industry and experts on other relevant topics as a way to complement and broaden our perspective. The key actor interviews were designed to assess general levels of understanding and interest in the concept of resilience and collect more specific details related to the LWR projects at each site. One of the benefits of these conversations was their contribution to understanding the connections among policies, development interventions and local context.

The conversations were conducted as semi-structured interviews, including questions to assess the current state of natural, financial, social and human assets within the communities. These four assets were selected as having the most direct connection to resilience in the projects, but details around physical, political and cultural assets emerged in nearly every interview. After determining a general sense of the asset allocation and state for the target communities, the interview moved to threats and opportunities associated with climate change. We then explored the concept of resilience, including their understanding of the term as well as perceptions of strengths and weaknesses within the communities, which could impact their resilience capacity. Although we were explicit that this was not a project evaluation, the interview closed with questions specific to existing collaborations and whether they had suggestions for project-related adjustments to improve impact.

6.2 HOUSEHOLD SURVEYS

To identify the target population for the survey, project participants were stratified by community and then proportionally by project participation levels. Limits of time and resources prevented a fully randomized sample, so the research team worked with local partners to recruit study participants that included a range of ages, both men and women, and different project participation levels. In each site, research team members partnered with representatives from local NGOs and/or cooperatives. These country teams then reviewed and refined the survey instrument to ensure it was appropriate to the local context and to adjust language to be locally familiar. A sample of survey themes and indicators follows in Table 3.

Table 3 . Key themes used in household surveys for assessing resilience in coffee dependent communities.

Factor	Indicator
Food Security	Months of Adequate Household Food Provisioning (MAHFP)
Natural assets	Condition of soils, agricultural productivity and type of management (organic or conventional), plant cover, access and rights to land and resources
Social assets	Organizational strength and capacity, access to support networks
Financial assets	Access to cash and credit, number of income sources and % dependency
Human assets	Educational levels, access to trainings/information, food security status
Physical assets	Productive infrastructure (food storage and access/storage options for water, access to markets)
Political assets	Links to political powerbrokers and advocates

6.3 FOCUS GROUPS

The focus groups were designed to engage project participants in a dialogue focusing on the following three themes: 1) Vulnerabilities, shocks and stresses; 2) Coping strategies; and 3) Conceptualization of resilience. This information was triangulated with data from the survey and key actor interviews. To gain context and elicit active participation, we conducted an exercise where community members generated seasonal calendars; documenting climatic and agricultural activities, as well as shocks and stresses experienced in the previous year. These calendars served as a reference for discussions on vulnerability, responses and resilience strategies. The discussions then focused on resilience and livelihood definitions and examples obtained from the surveys, in order to document common perceptions of opportunities and challenges in responding to the shocks and stresses identified. To ensure that we were using adequate terms and concepts, we provided definitions for key terms and ended up with feedback specific to projects, participant involvement and the potential for cultivating resilience in their communities

7. DATA ANALYSIS

7.1 QUANTITATIVE ANALYSIS

7.1.1 Descriptive Statistics

Data from the surveys was processed into Microsoft Excel spreadsheets and then transferred to statistical packages to explore trends and calculate descriptive and summary statistics (e.g., ranges, means, frequencies, standard deviations, etc.). All statistical procedures were done using SPSS version 22, JMP version 12.0 and R version 3.2.3.

7.1.2 Cluster Analysis for Typology

Classifying farmers or households into groups or types can help to identify differences and similarities between individual farms/households, which can be useful when planning development interventions. To assess if there were different groups or 'farmer types' within the samples in each country, we conducted a two-step cluster analysis, a procedure frequently used to define typologies, based on multiple variables. To separate the different types or groups, we used 4 variables that we directly related to the resilience of natural, social, physical and human assets, as follows, 1) total number of agroecological practices reported; 2) total plant diversity (# of reported plant species); 3) total number of reported income sources; and 4) the total amount of owned land. For more information on the clustering procedure see Appendix 2.

7.2 QUALITATIVE METHODS

When available, the audio and video recording from interviews and focus groups were transcribed. Notes from interviews and focus groups were substituted for transcripts where either there was no recording or the quality was poor. These documents were then reviewed for key word/concepts, resulting in a matrix of themes. The emerging themes were then analyzed and triangulated with information from the survey and interviews. This data was processed and interpreted by the entire research team.

To visually estimate a qualitative positioning of cluster groups, from the perspective of resilience and vulnerability, we developed risk/opportunity matrices for three themes we considered of key importance, including: 1) agroecosystem condition; 2) coffee production and quality; and 3) information and support networks. To do this we used variables from the surveys, focus groups and interviews, as well as the ARLG team's knowledge for each one of the themes. See Appendix 4 for a more detailed description of the variables and their influence on positioning in the quadrants.

8. RESULTS

In this section we present results that were similar for all of the cases (Section 8.1), as well as more detailed information on context and data for each of the countries.

8.1 FARMER TYPOLOGY

We conducted a cluster analysis, based on the survey data, to classify the farmer populations of the three countries. Given the distinct circumstances (economic, political, geographic, among others) across the three study sites, it is notable that the same two clusters broke out for all three countries (Table 4). The first group or type we termed *smaller, less diverse*, given that they had smaller landholdings and less diversity of plants, agroecological practices and income sources. The second group we termed larger, more diverse, because the landholdings were larger and they had higher plant diversity, number of agroecological practices implemented and number of income sources. It is important to note that across sites, the average landholding was 2.6 ha, so despite a distinction between larger and smaller – we are describing individuals and families that all qualify as smallholder farmers. Additional data associated to the clusters is presented both in each country section and in the synthesis.

Table 4 . Farmer types and mean values of key factors used in the clustering.

Country	No. of Farmers per Type (%)	# of Income Sources	# of Agro-ecological Practices	Total Land Owned (ha)	Total Plant Diversity
Honduras (n=60)	Type 1– smaller/less diverse: 37 (62%)	2.8*	5.5*	2.05	13.9*
	Type 2 – larger/more diverse: 23 (38%)	4.1	11.9	2.79	20.9
Nicaragua (n=70)	Type 1– smaller/less diverse: 40 (57.1%)	1.8*	5.6*	1.7	10.5*
	Type 2 – larger/more diverse: 30 (42.9%)	2.8	10.7	2.8	17.4
Haiti (n=71)	Type 1– smaller/less diverse: 30 (42%)	4.43*	16.90	0.86*	18.37*
	Type 2 – larger/more diverse: 41 (58%)	6.56	18.69	2.7	21.78

* Figures are significantly different for each type, at the $p < 0.01$ level, using a Man Whitney U test.

Variables used as livelihood outcome indicators such as shade type, access to irrigation infrastructure, access to credit, etc. were standardized to a scale between 0 and 1. See Appendix 3 for a more detailed explanation on what these variables represent and how they were calculated. Continuous variables were normalized using a feature scaling procedure. Categorical variables were transformed to binary data (0, 1) and averaged to calculate a value within the 0-1 scale. These transformed measures were then depicted as 'spider' or 'amoeba' graphs for a comparison among countries (Figure 6, Figure 9, Figure 15) and between the two farmer types within countries.

8.2 HONDURAS CASE STUDY

8.2.1 Resilience Context

Despite some macroeconomic growth in the early 1990s and a quick rebound from the global economic crisis (World Bank, 2014), Honduras continues to score poorly on the UN Development Programme's 2011 Human Development Index (last one for 2011). The agricultural sector remains vital for the economy, with a decade-long contribution to GDP of around 13% (13.8 percent in 2014). Rural households make up about half of the national population, and between 50 to 60 percent of these families live in extreme poverty (World Bank, 2014), with higher rates for indigenous households.

The majority of Honduran coffee producers are smallholders (98.4 percent), with landholdings of less than 14 hectares. This group manages 81.4 % of the country's coffee growing area and 80.9 % of national production (FIC and IEH, 2013). Coffee prices are variable, with a peak during the 2010-2011 harvest at above $2.00/lb, followed by falling prices that stabilized around $1.00/lb, with a slight rebound for the 2014-2015 harvest (ICO, 2015). The recent incidence of coffee leaf rust or *roya (Hemileia vastatrix)*, severely affected the 2012-2013 harvest (ICO, 2015), resulting in average yield losses of between 20 and 25%. This included farms at elevations previously unaffected by the disease (at elevations of 1,100 to 1,600 masl). Strong production recovery was seen in the 2014-2015 harvest, mostly attributed to plantation renovation and expansion (FEWS, 2015).

Climate change is expected to have a severe impact on the suitability of coffee production in Honduras. Climate models specific to coffee anticipate over 20 percent reductions in yields by 2050 in some of the highest production zones (Läderach et al., 2010). In addition, between 1995 and 2014, the country suffered the worst impacts from extreme weather than any other country in the world, based on an average of annual Climate Risk Index scores. While this score was driven largely by Hurricane Mitch in 1998, the country has experienced 73 additional events, with losses amounting to 2.23 percent of GDP (Harmeling and Eckstein, 2013). Many farmers are also exposed to worsening drought conditions, which affect not only coffee, but also the maize and beans that coffee families grow for consumption. These droughts can have serious implications for food security in coffee regions. For both 2014 and 2015, grain farmers in the Dry Corridor region of Honduras suffered crops losses due to drought during the first planting season (May-September).

Smallholders face food insecurity both from declining yields and volatile food prices. Maize, beans and rice constitute more than half of a typical diet in Honduras (FEWS, 2015) so food price volatility can have a large impact on rural households. Maize prices between 2014 and 2015, rose above 5-year averages, but have begun to decrease due to secondary harvests and imports from Mexico and the United States (GIEWS, 2015). Although nominal prices for red beans were very high (20% above 5-year averages) in 2014, they have returned to average levels as a result of good 2015 harvests and imports (GIEWS, 2015). With drier and hotter weather predicted for 2016, households are likely to suffer mounting stress and loss of critical livelihood assets (FEWS, 2015).

Honduras' public sector development planning process is guided by two long-term plans, the Nation's Plan (2010-2022) and the Country Vision (2010-2038). The National Strategy on Climate Change (2010) has been articulated with these plans, as a requirement under the UN Framework Convention on Climate Change. Along with the Law on Climate Change (2014), policies and programs related to climate change resilience are mainly carried out through the Secretariat for Agriculture and Livestock (SAG) and the Secretariat for Natural Resources and the Environment (SERNA). To address food insecurity, the Government has responded to recent food deficits by allowing large grain commodity purchases, particularly from Mexico and the United States, at near-zero tariff levels. The Government also moved to freeze prices on 20 basic food products (including maize, beans and rice) from November through January to avert price spikes (GIEWS, 2015; FEWS, 2015). Additionally, the Government is paying a guaranteed price for red beans (HNL 1,000). Government intervention in the price of grains affects smallholder coffee farmers in two ways. First, those that grow grain for consumption are not able to grow all that is needed for their families. Hence, annually they have to buy a proportion of the grain needed to sustain their families. High prices usually result in food insecurity for this group (Caswell et al., 2012). In second, some coffee farmers also depend on grain sales (especially maize) to generate income. For this group, low prices from government policies may result in decreased income.

8.2.2 Project Description and Organizational Profiles

Lutheran World Relief (LWR) is working with the Christian Organization for Honduran Integrated Development (OCDIH, for its Spanish acronym) on a project titled 'Food Security of the Maya Chortí'. OCDIH is a national-level non-government organization (NGO) with a long history of working with the indigenous Maya Chorti population, which the project targets. Although this project did not originally include a resilience component, project activities that evolved (drought response) as well as similar farming systems (coffee, maize & beans), pointed toward potential alignment with the resilient specific programming implemented in coffee regions of Nicaragua and Haiti. Key project facts are presented in Box 1.

BOX 1: Key project facts

Title: Food Security of the Maya Chortí (FSM)
Goal: 12 Maya Chortí communities in the Copán department improve their levels of food security.
Objective 1. Families increase food production on their farms.
Objective 2. Families increase income through local markets (coffee and vegetables).
Objective 3. Families reduce post-harvest crop losses.
Objective 4. Families have a more balanced diet (diversified) through sustainable practices.
Number of participants: 300 men and 300 women.
Project duration: January, 2014 to September, 2016.
Total budget: $ 376,976

The Food Security of the Maya Chortí (FSM) project is in its final year and appears to have met or exceeded its original goals. The farmers and other actors we interacted with had very positive feedback about OCDIH, and the execution of the FSM project. This was corroborated by the data from surveys, the focus group and interviews.

8.2.3 Key Actors

Table 5 presents key actors identified and their specific roles with relation to the project. The FSM project is in its last year of execution, and there is uncertainty in terms of accessing additional resources to continue. In terms of resilience, the project was able to raise awareness in participants on the livelihood impacts of climate changes. This resulted in an easier understanding of the notion of resilience, as applied not only to climate change impacts, but also to food security and coffee price volatility. The project has been successful in strengthening the coffee production and processing capacity of many households. This has included production trainings in collaboration with IHCAFE, as well as the establishment of wet mills and driers in a number of communities. In addition, the importer OLAM has established a favorable buying contract with the farmers of the project, mediated through both LWR and OCDIH. Other clear outcomes of the project are improvement in the infrastructure to store grains (silos), the establishment of small irrigation infrastructure and soil conservation practices for grains, vegetables and homegardens. These activities tie in to the issue of drought, which farmers reported as the more severe effect they are facing, as it offers opportunities to better manage crops under these conditions. OCDIH expressed that one area where progress has been made, but requires additional work is strengthening farmer organization so that they can better engage with other actors and networks.

Table 5. Key actors and their roles in the Honduras case study.

Organization	Description
LWR	LWR was the primary funder for the FSM Project and has provided oversight and support to OCDIH
OCDIH	OCDIH is the primary executor of the project
OLAM International	OLAM is an international coffee exporting company that has been buying coffee from farmers in the FSM project. Through its sustainability and livelihood charter initiatives OLAM has supported the FSM in implementing small processing infrastructure with farmer participating in the project.

8.2.4 Site and Family Context

In this section we present information about the site and basic demographic data on the 60 families that we surveyed during our research visit. Participants were drawn from 10 communities representing the 3 municipalities covered by the project (Cabañas, Copán Ruinas and Santa Rita), all within the department of Copán in western Honduras (Box 2). Poverty indices for these municipalities are among the lowest in the Copán department and nationally (Alvarado, 2013). The families targeted by the project are predominantly of the Maya Chortí ethnicity, but also include some mestizo farmers. In general, this population is dependent on the production of maize, beans and coffee, along with homegardens.

In Honduras, it is important to note that the Maya Chortí families started coffee farming relatively recently (most within the past decade). This is a sharp contrast to other areas of Mesoamerica, where generations of families cultivating coffee has led to deep aspects of identity associated with coffee. Maya Chortí farmers have traditionally been connected to growing basic grains and to a subsistence farming strategy. Many Maya Chortí were previously farm laborers on larger coffee estates, which provided valuable experience as they established their own coffee parcels. Coffee represents an opportunity to engage with a broader economic system, but it also requires changing patterns of production and commercialization. As they are still relatively new to coffee production, there is no formal producers' organization or cooperative to support coffee farmers in this region. Coffee sales are currently facilitated through intermediaries or 'coyotes' who purchase individual lots from farmers, but many coffee producers expressed interest in establishing a more formal farmer association. The FSM initiated a relationship with OLAM (an international exporting company) that is leading to improved production practices and connections to new markets.

BOX 2: Selected family demographics of surveyed households (n=60)

Average number of family members per household: 5.5
Average number of family members of less than 5 years of age: 1
Average number of family members of more than 60 years of age: 1
Average family members with Primary school: 48% Secondary school: 18% **University:** 31%
Average area of owned land: 2.34 ha
Average area of rented land: 2.7 ha (n=21; number of households out of a total of 60 that rented land)
Average total land area: 3.35 ha.
Households growing coffee: 100%
Households growing maize: 88%
Households growing beans: 72%

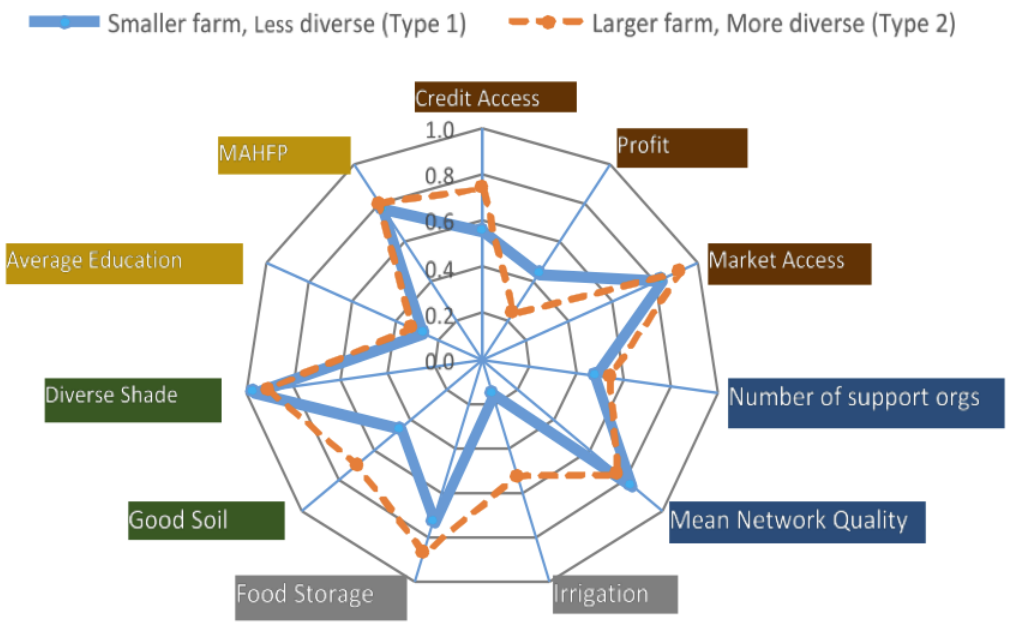
8.2.5 Resilience Factors

The following subsections outline general trends in livelihood asset allocation, use of agroecological practices, perceptions of climate change, coping strategies and interactions of key variables of interest with food security and soil health (the variables we selected as resilience outcome proxies). Details on how the livelihood asset categories were ranked are found in Appendix 3. Further discussion of the results is found in Section 9, which includes regional comparisons across the case study sites.

8.2.6 Farmer Typology

As mentioned in Section 8.1.1, survey responses from each country divided into two categories (typologies), where Type 1 represents a profile of smaller total area of owned land, fewer agroecological practices, lower plant diversity and lower incomes, and Type 2 represents a profile of larger total area of owned land, more agroecological practices, higher plant diversity and higher incomes. For Honduras, 62% of the households were Type 1 and 38% Type 2. While the FSM project includes participants from the Maya Chorti indigenous group and farmers who consider themselves of a mixed or 'mestizo' racial background, differences in percent of indigenous representation was not significant between the farmer types. Indigenous farmers were similarly represented in both of the clusters, with 65% of Type 1, and 74% of Type 2 respondents identifying as Maya Chorti. Households from each group/type differ significantly in terms of number of income sources, number of agroecological practices applied in their different plots, and total number of plant species reported. No significant differences were observed in terms of total land owned.

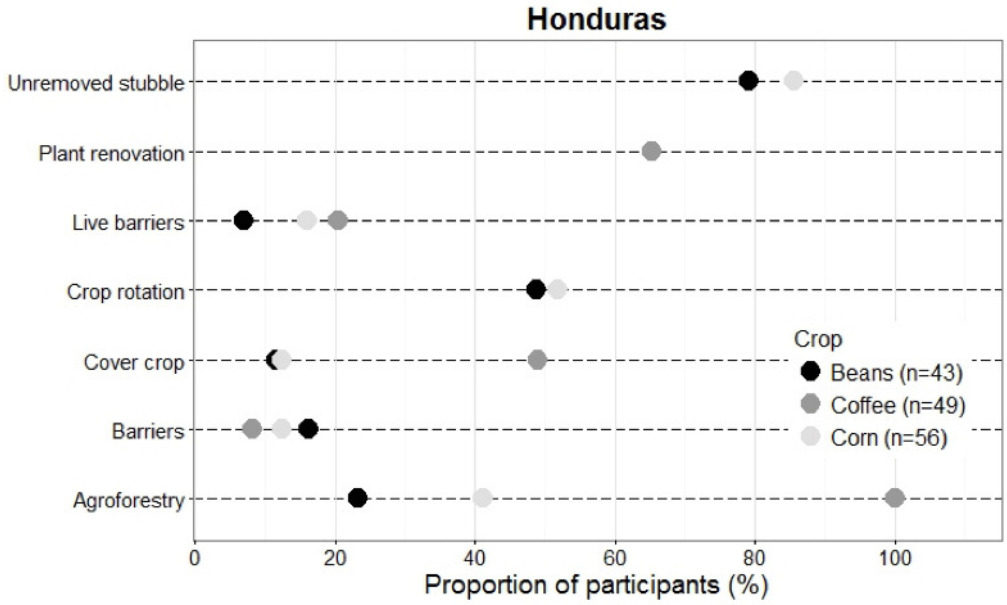
Figure 6. Honduras Livelihood asset categories for the two types of farmer groups, color-coded as follows: Grey=physical assets; Green=natural assets; Yellow=human assets; Brown=financial assets; Blue=social assets.



In Honduras, Type 2 respondents (larger, more diverse farms) have better access to credit, report better soil, food storage and irrigation infrastructure, and more reliable market access. Interestingly, they are also reporting lower levels of profitability (Figure 6). Type 1 respondents (those with smaller, less diverse farms), appear to be less diverse in terms of biodiversity, but have higher levels of diverse shade cover, are more satisfied with the organizations they connected with, and also report higher levels of profitability. Across both groups, growers reported difficult road access, but an increasing number of producers are setting up small wet mills and dryers to process their coffee. This is an important step given the production limits associated with their lack of a formal producer's organization.

In Honduras, there were differences in terms of the proportion of farmers using a specific agroecological practice for each crop (Figure 7). In coffee, all farmers reported using agroforestry, and more than 60% renovated their plantations (removing old/diseased plants and replacing them with new stock). Less than 50% used a cover crop in their coffee plantation. Unremoved stubble (leaving roots and some stem in place post-harvest) was used by more than 80% of farmers for their corn and bean crops, followed by crop rotations by about half of the farmers. All of the other practices that were reportedly used in corn and beans were only used by 41% or less of the Honduran farmers. Considerations regarding the appropriate mix of activities and diversification strategies for maximizing resilience capacity are further discussed in subsequent sections.

Figure 7. Most frequently mentioned agroecological practices in Honduras, applied by crop.



8.2.7 Farmer Perceptions of Climate Change Impacts

When survey participants were asked how they had felt the effects of climate change in the past five years, they offered a range of responses, from pest and disease pressure to crop loss. Table 6 presents a combination of responses gathered through open-ended survey questions. It is clear from the survey that drought affected all of the crops and was of great concern to farmers. The pressure from *roya* was much less severe than expected, given the severity of infestation in the Central American region, between 2011 and 2014 (Avelino et al., 2015).

Table 6. Perceived shocks/stresses attributed to climate change by survey participants (n=57).

Shock/stress	% Surveyed Farmers that Mentioned this Effect
Drought (in general, all crops)	81
Coffee leaf rust	16
Other or no response	3

8.2.8 Farmer Coping Strategies

Table 7 presents a combination of responses about shocks/stresses and coping strategies gathered through open-ended survey questions and from the focus groups. Some of the responses presented in Table 7 are strategies that farmers are already implementing, while others are ideas about how to cope in the future.

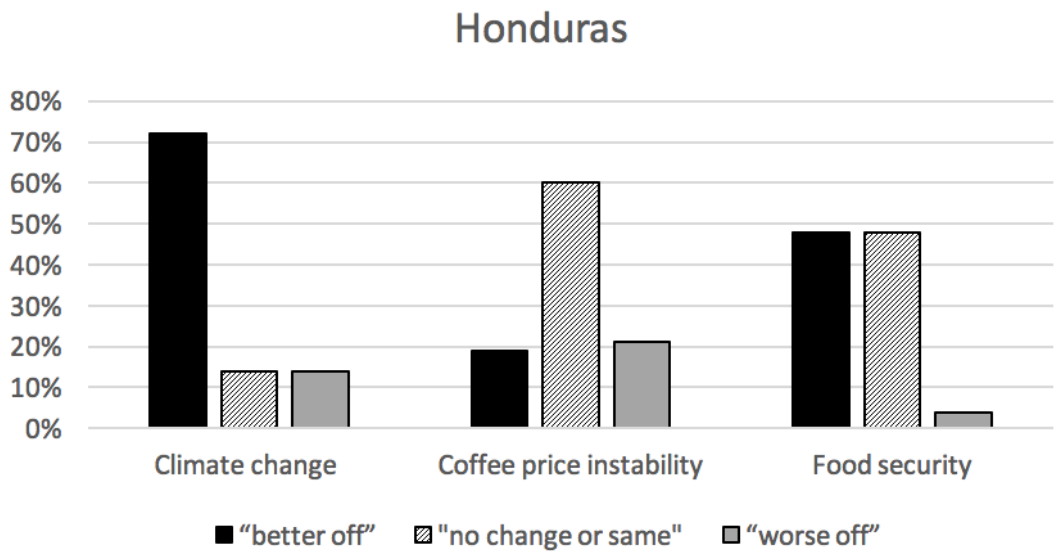
Table 7. Combined summary of reported shocks, stresses and responses from surveys (n=60) and a focus group with 10 participants.

Type of Shock/Stress (Source: survey and focus group)	% of interviewees reporting in survey (n=60; Source: surveys)	Responses (Source: focus group)
Drought	63%	■ Staggered planting ■ Funds to fertilize ■ Irrigation systems: pumps & equipment
Coffee leaf rust	17%	■ Biofermented foliar sprays ■ Select better seed and varieties ■ Maintain soil ■ Spraying equipment ■ Chemical fungicide
Prices and coffee value-addition	N/A	■ Improve price through: ✔ Better quality ✔ Training ✔ Better markets ■ Drying equipment ■ Processing- depulping and drying ■ Direct buyers ■ Combination of all of the above
Income generation and management	N/A	■ Plant other crops that generate income (cocoa, vegetables Malanga [Xanthosomas], etc.) ■ Improve financial management capacity ■ Improve access and conditions to credit
Food Insecurity	47% reported suffering from hunger months	■ Plan and store grains for hunger months ■ Have a grain silo for each family ■ Sell less crops (keep more for the house) ■ Have funds ■ Homegardens ■ Plant diverse crops

As presented in Tables 6 and 7, the most frequently cited challenge from climate change was drought, followed by coffee leaf rust. For drought, financial support and irrigation systems were among the most frequently cited responses. Ideas on how to deal with the coffee leaf rust were more varied, and included both conventional and ecological approaches. In terms of improving market prices for coffee, there was a strong sense that there is ample room for improving coffee quality through enhanced processing, as well as finding better markets. Another recurrent theme of discussion in the focus group was financial management and its relationship to dealing with all kinds of shocks and stresses. Famers felt their capacity to make sound financial decisions could be improved, and that this would also contribute to dealing with other shocks like drought, crop management and marketing. Less than half of the respondents reported food insecurity, and there was a sense that adequate grain storage and crop diversification for both the market and consumption were efficient strategies to keep this stress in check.

8.2.9 Categorization of Coping Strategies

Figure 8. Coping strategies for Honduras.



We used scenario/recall questions within the survey to inventory the responses to three categories of shocks/stresses identified as relevant to coffee dependent communities (climate change, low coffee prices and food insecurity). Some participants expressed a feeling of helplessness (saying things like, "you can't do anything"), while others described innovating to work around the problem (e.g., designing new irrigation systems). An adjusted version of this question was also included in the focus groups. Participants often listed multiple coping mechanisms for particular threats, and/or mentioned that their actions provided short-term relief but left them either at status quo or worse off in the longer term. Loans were cited multiple times as an example of this kind of short-term fix that leaves producers worse off in the long

run. As shown in Figure 8, survey respondents reported that their coping strategies related to food security were non-erosive, either leaving them better off or equal to their previous condition. Responses to coffee price instability were less positive, with just over 20% reporting that their coping strategies are leaving them worse off. For those who have implemented climate change coping strategies, feelings are overwhelmingly positive – with over 70% of respondents reporting that their actions have left them better off than before.

8.2.10 Interactions with Resilience Outcome Variables for Identified Farmer Types

As described in the methodology, we selected food security and soil health as our resilience outcome variables, and used climate change events to gauge the greatest perceived covariate shock/stress for the population (Constas et.al., 2014). No significant differences between farmer types were observed on the number of months with food insecurity (thin months), reported soil quality for coffee or major climate change related impacts (Table 8).

Table 8 . Comparison of key resilience outcomes between farmer types (n=60)

		Perceived Coffee Soil Quality (% Frequency)[2]			Major Climate Impacts (% Frequency)[3]		
Farmer Type	**# Thin Months[1]**	**Good**	**Medium**	**Poor**	**Roya**	**Drought**	**Other**
Type 1 - smaller, less diverse	1.6	46%	51%	3%	22%	74%	4%
Type 2 - larger, more diverse	1.4	70%	30%	0%	13%	83%	4%

1No significant differences using a Mann Whitney U test; **2** No significant differences using a Chi Square test; **3** Major climate effect responses included both 'roya and drought', which were equally divided into the roya and 'Drought' categories; the 'Other' category included rain and none. No significant differences were found using a Chi Square test. See Appendix 2 for more detail.

8.2.11 Associations Among Key Variables

To determine if different factors/variables affected each other, we tested for correlations among number of thin months, perceived soil quality and climatic impacts and the variables used for classifying the farmer types (# income sources, # of plant species, total owned land, and # of agroecological practices). The only significant, positive association found was # of thin months with total number of plant species reported. This points to the unclear relationship between food security and agrobiodiversity in the literature. Agroecologists have proposed that higher agrobiodiversity tends to lead to increased food security (Gliessman, 2015), but empirical findings have been mixed (Remans et al., 2011). However, this association contradicts responses from the focus group, which report crop diversification as a response or coping strategy to address the stress generated by lack of income and food insecurity. No other significant associations were found among variables. These analyses reinforce the need for a deeper exploration of how agroecological practices (beyond number of practices applied) may be affecting *roya*, drought conditions and soil quality on the farm.

SURVEYS

Household-level surveys allow us to glean into the realities of rural families in a given locality. Surveys have many advantages that help us to better understand the situation of a locality, including the possibility to get a 'sample' or a group that allows for numerical or quantitative description and analyses. This may include how many families report a specific problem or use an agricultural practice, the average number of people in a house, and other resources that may affect households differently in the same place (e.g., access to water or electricity).

As external actors, it is very important to ensure that our instrument and methods bring the least possible bias, and are well accepted, in terms of language and approach, by the people that we interview. Over the years, we have adopted the strategy of recruiting young people from the locality to work as paid research assistants. This practice has provided several benefits, including them sharing their knowledge of the local context and geography, knowing many of the people we seek to interview, and having ideas and opinions about the factors we are exploring. Specifically related to surveys these young people serve as important validators of the language that we use, the time that it takes to answer, and pointing out sensitive topics, or important factors that may have been left out. In Honduras, we had the help of 4 committed young men, who provided invaluable assistance to design, validate and conduct the surveys. It is also our hope that the learning is mutual and that the research assistants gain new knowledge through the training days we offer before undertaking the field work, as well as from the frequent conversations over meals or while driving to a particular location.

One of the most challenging issues we face when conducting surveys with smallholder farmers is obtaining a random sample. A random sample is one that is chosen without any pre-determined reasons or entirely by chance, and can potentially yield a diversity of perspectives. It is hard to do this, as the projects, cooperatives or NGOs that work with smallholders tend to have working relationships with specific groups that many times are selected as the most available or knowledgeable people to interview. To deal with this we emphasize the need for random samples. Since this is sometimes hard to verify, as was the case for this study, we adjust our analyses by using non-parametric statistics that allow for testing with non-random samples.

surveys are good at showing us what is there and what trends are present, but may not be as good for us to understand why we encounter a specific condition. In order to glean at these reasons we complement our surveys with focus groups and other types of interviews that allow a more open dialogue. In addition, and if resources permit it, we also like to measure biophysical factors. A 'triangulation' or bringing together of all of this information is what allows us to create a more realistic picture of a given reality. The picture below shows two local and one external team member practicing a survey.

8.3 SUMMARY OF THE HONDURAS CASE STUDY

The importance of social networks is a recurring theme in discussions about how to increase resilience (Keck and Sakdapolrak, 2013), and OCDIH's willingness and ability to reach out and work with many organizations as collaborators has been critical to the success of the FSM project. A solid trust in the organization and years of investment in working with these communities and families has facilitated increased levels of confidence among all parties and sets a strong foundation for future increases in resilience capacity. Food insecurity was low compared to other similar coffee producers of Mesoamerica (Caswell et al., 2012), attributable, in part, to FSM interventions.

Some key actors and project participants expressed uncertainty around interest in and suitability for Maya Chortí to pursue coffee production as a primary income generating activity, since they are relatively new coffee farmers and still maintain close ties to maize and beans based subsistence agriculture. These questions are especially relevant given the relatively low elevations of these communities and associated uncertainty around whether climate prediction models mean that cultivation of Arabica coffee is not feasible in the region. The most significant vulnerabilities identified by study participants were: 1) Climate change (namely drought and coffee disease pressures/pests); 2) A lack of formal producer organizations (contributing to a lack of resources associated with improving production practices, and fewer markets for selling their crop); and 3) Low levels of confidence around financial management. Built and social assets represent other areas of relative weakness. Each of these represents areas that merit consideration in the design of future resilience interventions for these communities.

8.4 NICARAGUA CASE STUDY

8.4.1 Resilience Context

Nearly a quarter of a million people, representing one-third of Nicaragua's working population, either directly or indirectly depend on coffee for their livelihood (Renton, 2014). Coffee constitutes 20 to 25% of Nicaragua's export revenues (Laderach et. al., 2010), and Nicaragua's annual coffee production has remained relatively steady from 2012-2015, with a moderate increase of 6% between 2014 and 2015 (ICO, 2015). While 97% of the country's coffee producers are small-to medium scale, the largest 3% produce half of the country's annual harvest (Cafenica, 2016). Within the agricultural sector as a whole, the role of smallholder farmers is notable – 75% of farmers hold less than 3.5 hectares, and yet they produce 80% of the basic grains, 65% of livestock products and 56% of export crops (IFAD, 2014). Almost 50% of the country's population lives in rural areas, and 80% of this population depends on agriculture for their livelihood (IFAD, 2013).

Although Nicaragua's coffee farms were less affected by the coffee leaf rust (*roya*) than some countries of Central America, smallholders in parts of Nicaragua, such as Jinotega, lost up to 60% of their harvest in 2012/2013, resulting in drastic income reduction for an already vulnerable population (Oxfam, 2014). Both demand and wages for coffee day laborers fell in 2014, as a result of the coffee leaf rust outbreak (FEWS, 2014; LWR, 2014), with continued lower harvests extending the difficulties associated with *roya*. Three primary challenges to confronting the *roya* epidemic have included insufficient financing/resources to support long-

term investments, and both a lack of appropriate technologies and short supply of technical assistance toward improving coffee production practices (Cafenica, 2013; LWR, 2014). These combined factors are clues to why poverty in Nicaragua, and in particular rural poverty, continues to be a challenge; nearly two-thirds of Nicaragua's rural population lives in poverty, with just over a quarter in extreme poverty (IFAD, 2014).

Climate change threatens coffee production throughout Mesoamerica, with projections for increased temperatures, 5 to 10% lower rainfall, more erratic precipitation, extreme weather events, and increased pest and disease damage (Laderach et. al., 2010). Nicaragua is one of the most vulnerable countries to climate change in the region, due to water scarcity and relatively low elevations (Oxfam, 2014). Maximum and mean temperatures are expected to increase by 2° C in Mesoamerica, which could shift the suitable Arabica coffee altitude range from 400-2000 masl to 800-2500 masl (Ovalle-Rivera et al., 2015). Nicaragua's land area suitable for coffee production has been predicted to diminish by up to half, with areas such as San Ramón, Tuma La Dalia and Matagalpa becoming unsuitable for coffee production by 2050. Jinotega, Nueva Segovia and Madriz will be better positioned to continue in coffee, but their success will depend on farmers' ability to adapt their agronomic management to new conditions (Läderach et. al., 2010).

Production of staple food crops has also suffered as a function of changing climatic conditions. Prolonged drought resulted in significantly reduced harvests of basic grains in Nicaragua in 2014. The primary harvest of both white maize and red beans were down 75% in 2014 compared to 2013 (FEWS, 2014), and due to El Niño this trend continued into the first harvest of 2015 (FAO/GIEWS, 2015). The 2012 Global Hunger Index ranks Nicaragua 21st of 79 countries with a score of 9.5, categorized as a "moderate hunger" situation[2]. For smallholder agricultural producers, reliance on just a few crops (sorghum, maize, beans, coffee) makes rural households more vulnerable to market volatility and extreme climatic events. In August/September of 2015, for example, white maize prices spiked in Nicaragua at the same time that coffee prices dipped below $1.20 per lb. These price trends exacerbate problems for coffee dependent families who rely on coffee as their primary source of cash income to cover food and other family expenses, resulting in what has been termed as the 'hungry farmer paradox'(Bacon et al., 2014).

Both the Nicaraguan government and international interests have made investments in securing the future of coffee within the country. The Nicaraguan government promised support for renovation of damaged coffee plots and increased access to loans, (as part of Law 853 for "The Transformation and Development of Coffee Production: Law 871 is the amended and current version of this legislation). The success of this governmental support is debated, but the coffee industry and international NGOs have also committed significant support, including funds for renovating coffee plots, increasing access to loans, and setting up demonstrations to test the potential for improved coffee varieties in the Nicaraguan landscape.

2 The Global Hunger index is calculated based on three indicators: 1) proportion of population undernourished; 2) prevalence of underweight children under age of 5; and 3) mortality rate of children under age of 5. Countries are ranked on a 100 point scale with values between 5 and 9.9 reflecting "moderate hunger", values between 10 and 19.9 reflecting "serious" hunger, 20 to 29.9 categorized as "alarming" and values exceeding 30 categorized as "extremely alarming" (IFPRI, 2013).

There is no overarching coordination of efforts, so some areas are beneficiaries of multiple projects, while others are less supported. There is a perception among many smallholder coffee producers that a disproportionate share of investments and attention has been directed toward the larger-scale producers.

8.4.2 Project Description and Organizational Profiles

Lutheran World Relief (LWR) is working with Cafenica, Centro Humboldt and Centro Intereclesial de Estudios Teológicos y Sociales (CIEETS for its Spanish acronym) on a project titled 'Resilience in the Coffee Sector to Climate Change'. Cafenica is a non-profit association consisting of 11 farmer organizations; bringing together more than 10,337 smallholder coffee producers in Nicaragua and representing nearly a quarter of the smallholder coffee producers in Nicaragua (CAFENICA, 2016). All of its member organizations are Fair Trade Certified™ and produce a large part of the country's organic, certified coffee. El Centro Alexander von Humboldt (Centro Humboldt) is a non-governmental organization that works to promote a territorial development approach that is environmentally sustainable, and which includes a focus on equity and social participation. Centro Humboldt is one of the most recognized environmental organizations in Nicaragua and Central America, and in 2012 they published a "Map of risks, processes, policies and actors associated with climate change in Nicaragua". CIEETS is an institution consisting of evangelical churches and ecumenical, social and agrarian organizations working toward sustainable human development in Nicaragua's most vulnerable communities.

This project was designed to benefit residents of communities that were hardest hit by the roya epidemic – both coffee producers and farmworkers who pick coffee – and includes a variety of strategies including the development of a climate monitoring network, the implementation of agroecological management practices, and the development of seed banks. The project's multi-pronged approach reflects both the complex and interconnected vulnerabilities faced by these populations, and the diversity among project beneficiaries themselves (Box 3). Project activities are being implemented in partnership among consortium members, with facilitation and oversight by LWR.

BOX 3: Key project facts

Title: Resilience in the Coffee Sector to Climate Change
Goal: Families in the coffee sector increase their resilience against the effects of climate change.
Objective 1. Coffee producing families have more climate resilient coffee varieties.
Objective 2. Families in coffee producing areas have greater capacity to adapt to climate change.
Objective 3. Families in coffee producing areas have access to livelihoods that are more resilient to climate change.
Number of participants: 616 households in communities hardest hit by the coffee leaf rust crisis.
Project duration: November, 2014 to September, 2017.
Total budget: $ 450,000

8.4.3 Key Actors

The missions of the organizations comprising the consortium for the Resilience Project are outlined in Section 1.2 above. Table 9 explains specific roles within the project for each of the partners. The Resilience Project is currently in its second year of activities. The first-year activities were concentrated on the baseline study to determine vulnerabilities within the communities, establishment of 14 climate stations that are set up to measure air and ground temperature, rainfall, and relative humidity. In total the project will include 16 climate stations, as CIEETS already had two pluviometers set up in San Ramon from a previous project. Cafenica selected the locations for the new climate stations to represent the different altitudes and climatic conditions experienced by their membership. Cafenica and Centro Humboldt are collaborating to establish a virtual climate-monitoring network, where information from the climate stations will eventually contribute to an early warning system (with alerts around upcoming weather events and the implications they have for pest/disease pressure). Once the climate stations have a year's worth of aggregated readings, Centro Humboldt will be able to utilize the data to model future climate scenarios.

Table 9. Key actors and their roles in the Nicaragua case.

Organization	Description
Lutheran World Relief (LWR)	LWR is the primary funder for the Resilience Project and has provided oversight and support to the consortium of partners
La Asociación de Cooperativas de Pequeños Productores de Café de Nicaragua (CAFENICA)	Cafenica is the primary point of contact for the project beneficiaries who are coffee producing families. Cafenica is coordinating the implementation of agricultural best management practices, including: establishing plant nurseries, setting up demonstration plots, providing technical assistance, facilitating trainings/ 'escuelas del campo', and supporting both the virtual network of technical assistance providers and promoters, and then will use these networks to disseminate timely alerts as part of the climate early warning system.
Centro Alexandro von Humboldt (Centro Humboldt)	Centro Humboldt is working closely with all of the partners to serve as the source of climate change expertise for the project. Centro Humboldt has set up the 14 climate stations, trained the climate monitors, and for the duration of the project will continue to maintain the database where daily readings from each of the stations are sent (integration of the 2 stations managed by CIEETS is forthcoming). Centro Humboldt will also facilitate trainings on climate adaptation strategies.
Centro Intereclesial de Estudios Teológicos y Sociales (CIEETS)	CIEETS is the main point of contact for the project beneficiaries who are coffee farm laborers and their families. They are working with project participants to conduct participatory workshops to identify community vulnerabilities and resources, and then choose from a menu of livelihood and dietary diversification strategies.

In addition to their role in the climate stations, Cafenica is establishing demonstration plots and using the technique of farmer field schools to promote agroecological practices, and assess the relative performance of improved coffee varietals. Cafenica has also set up two virtual networks using 'Whatsapp' telephone software to facilitate information sharing among technical service providers/promoters and coffee producers, as well as another among the climate monitors so that they can send their daily climate reports by text to the Centro Humboldt database. These two networks will eventually be utilized as part of the forthcoming climate early warning system.

For the population of farm laborers from Matagalpa participating in the Resilience Project, CIEETS has initiated a series of workshops that serve as a space for participatory evaluation of vulnerabilities and resources within the communities. It continues to assist with farm plans, the establishment and maintenance of seed banks and promotion of diet diversification through nutrition workshops, kitchen gardens and support for community members as they start to work with new food crops.

8.4.4 Site and Family Context

In this section we present information about the site and basic demographic data on the 70 households that we surveyed during our research visit (Box 4). Participants represented over 25 communities from 7 municipalities covered by the project in the departments of Matagalpa, Boaco, Madriz and Nueva Segovia. The survey sample was comprised of two distinct populations – coffee producers (from Boaco, Madriz and Nueva Segovia) and farmworkers from the region around San Ramon, Matagalpa.

BOX 4: Selected family demographics of surveyed households (n=70)

Average number of family members per household: 4.9
Average number of family members of less than 5 years of age: 0.7
Average number of family members of more than 60 years of age: 0.4
Average family members with Primary school: 87 % Secondary school: 44% **University:** 30%
Average area of owned land: 2.1 ha.
Average area of rented land: 1 ha (n=10; number of households out of a total of 70 that rented land)
Average total land area: 3 ha.
Households growing coffee: 76%
Households growing maize: 53%
Households growing beans: 51%

8.4.5 Resilience Factors

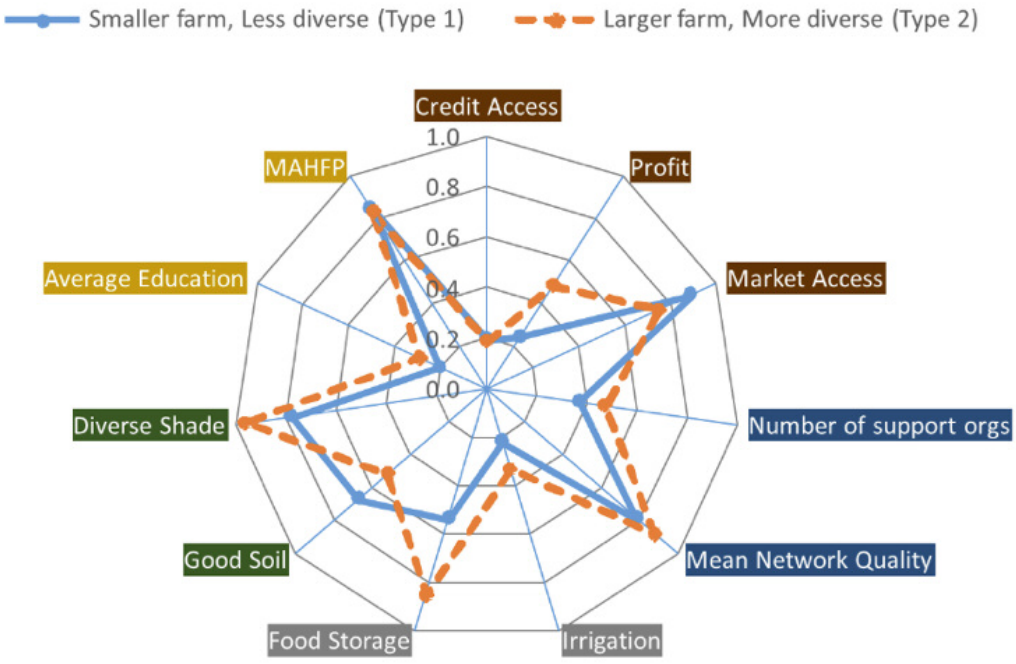
The following subsections outline general trends in livelihood asset allocation, use of agroecological practices, perceptions of climate change, coping strategies and interactions of key variables of interest with food security and soil health (the variables we selected as resilience outcome proxies). Details on how the livelihood asset categories were ranked are found in Appendix 3. Further discussion of the results is found in Section 9, which includes regional comparisons across the case study sites.

8.4.6 Farmer Typology

As mentioned in Section 8.1.1, survey responses from each country divided into two groups (typologies), where Type 1 represents a profile of smaller total area of owned land, fewer agroecological practices, lower plant diversity and lower incomes, and Type 2 represents a profile of larger total area of owned land, more agroecological practices, higher plant diversity and higher incomes. For Nicaragua, 57% of the households were Type 1 and 43% Type 2. For our sample, the households from each group differed significantly in terms of number of income sources, number of agroecological practices applied in their different plots, and total number of plant species reported. No significant differences were observed in terms of total land owned.

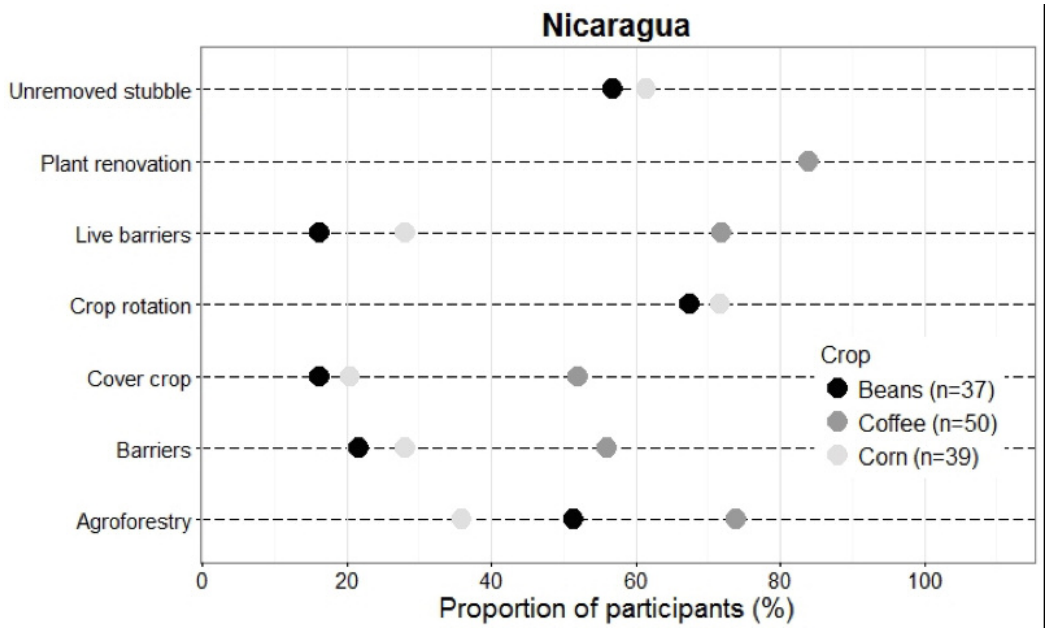
Despite our initial assumptions that the farm laborer population would be more vulnerable than their coffee-farming counterparts, the labor respondents were essentially evenly split between the two types (Type 1 - 55%, Type 2 - 45%). Almost half of farmworkers reported growing coffee on their own plots (9 out of 22), but their parcels were small (≤ 1 ha.) and included both coffee and food crops (primarily maize and beans). According to comments from the focus group, it appears that our survey may have over-sampled land-holding farmworker households, since it was reported that of the nearly 300 families in the zone, 70% live in 10x20 meter plots, forcing them to rent any land that is required for food production. Despite potential sampling challenges, interesting distinctions between the two Types emerge when they are used as filters for other asset categories (Figure 9).

Figure 9. Nicaragua Livelihood asset categories for the two types of farmer groups, color-coded as follows: Grey=physical assets; Green=natural assets; Yellow=human assets; Brown=financial assets; Blue=social assets.



In Nicaragua, Type 2 respondents (larger, more diverse farms) appear to be stronger in terms of physical and social assets, but have mixed results in terms of natural, financial and human assets. Type 1 respondents (smaller, less diverse farms) report better access to markets, and higher soil quality. A very slight difference was seen in terms of food security between the two types. Getting product to market is supported by strong infrastructure (maintained processing plants, good roads, etc.) once it is the hands of the cooperative, but there are still challenges with farm-gate to cooperative conditions. Across the two groups, households report very low access to credit.

Figure 10. Most frequently mentioned agroecological practices in Nicaragua, applied by crop.



Half or more of all Nicaraguan survey respondents reported using agroecological practices that help to minimize soil erosion and contribute to soil health, with more application overall of agroecological practices for coffee than for other crop systems (Figure 10). The suite of agroecological practices recommended by Cafenica as part of this project may be contributing to the relatively high levels of live barriers, renovation (removing old/diseased plants and replacing them with new stock), and cover crops reported by survey respondents.

8.4.7 *Farmer Perceptions of Climate Change Impacts*

When survey participants were asked how they had felt the effects of climate change in the past five years, they offered a range of responses, from pest and disease pressure to crop loss. Table 10 lists the effects that were most frequently mentioned. It is clear from the survey that drought affected all of the crops and was of great concern to farmers. In addition, the coffee leaf rust fungus (*roya*) was also perceived as severely impacting coffee plantations.

Table 10. Perceived shocks/stresses attributed to climate change by survey participants (n=57).

Shock/stress	Perceived shocks/stresses attributed to climate change by survey participants (n=52).
Drought	33
Coffee leaf rust	38
Other or no response	29

8.4.8 *Farmer Coping Strategies/Responses to Climate Change*

Table 11 presents a combination of responses about shocks/stresses and coping strategies gathered through open-ended survey questions and from the focus groups. Some of the responses presented in this table are strategies that farmers are already implementing, while others are their ideas about how to cope in the future.

It is worth noting the variety of agricultural management strategies proposed to deal both with drought and new disease/pest pressures. Complaints about the expense of inputs for fertilizers and pest control emerged from the focus group with farm laborers. While some respondents reported using the 'improved' corn varieties being distributed by the government, there was also mention of the benefit of local varieties that were being saved and distributed through the seed bank, which required fewer external inputs. Farmers also reported the importance of fruit trees as a food security strategy, positive results from experimenting with soil amendments and organic pesticides, as well as the benefits of cultivating turmeric and ginger, two crops that appear to be more tolerant to the current climate. Both family traditions and workshops offered by the cooperative and/or NGOs, were highlighted as important knowledge sources. Additionally, in contrast to the individual issues that were mentioned, it is important to note that some of the shocks/stresses discussed deal with structural issues, such as a perceived lack of political voice, land scarcity, and a general sense that the laws in place to protect against deforestation are not being enforced.

Table 11. Combined summary of reported shocks, stresses & responses from surveys (n=70) and 2 focus groups (n=27).

Type of Shock/Stress (Source: survey & focus groups)	% of interviewees reporting in survey (n=70; Source: survey)	Responses (Source: survey & focus groups)
Drought	66% of respondents reported negative impacts of drought on at least one crop (coffee, maize, bean or garden)	■ Agricultural best management practices ✔ Use of new coffee varieties that are designed to resist drought and roya ✔ Improved pruning practices ✔ Application of organic fertilizers (liquid and compost) and foliar sprays (changing application frequency and matching recipes to observed/predicted conditions) ✔ Use of cover crops like terciopelo, canavalia, gandul (serve both as live barriers and nitrogen fixers) ✔ Shade regulation ✔ Reforestation using varieties that will contribute both shade and organic material ■ Climate stations ✔ Alerts/reports from local observation teams ■ Reforestation ✔ Heightened awareness/conciousness around problems from deforestation ✔ Stronger enforcement of regulations ■ Systems for harvesting water ✔ Acequias/zanjas ■ Implement water conservation practices during coffee processing ■ Demonstration parcels, soil tests and other data to inform decisions
Coffee leaf rust, yield and quality	46% of respondents reported negative impacts from roya	■ Renovation of old and damaged coffee parcels ■ Use of new coffee varieties that are designed to resist drought and roya ■ Interplanting of caturra with new varieties ('Gallo Pinto') to try to manage disease risk but still maintain cup quality ■ Agricultural best management practices (see above) ■ Farmer field schools/technical assistance ■ Demonstration parcels, soil tests and other data to inform decisions ■ Solar driers for coffee to maintain quality
Coffee price	N/A	■ Producer investment in improving yield and quality ■ Selling to intermediaries/coyotes ■ Coop membership ■ Price premiums from certification (organic, fair trade)

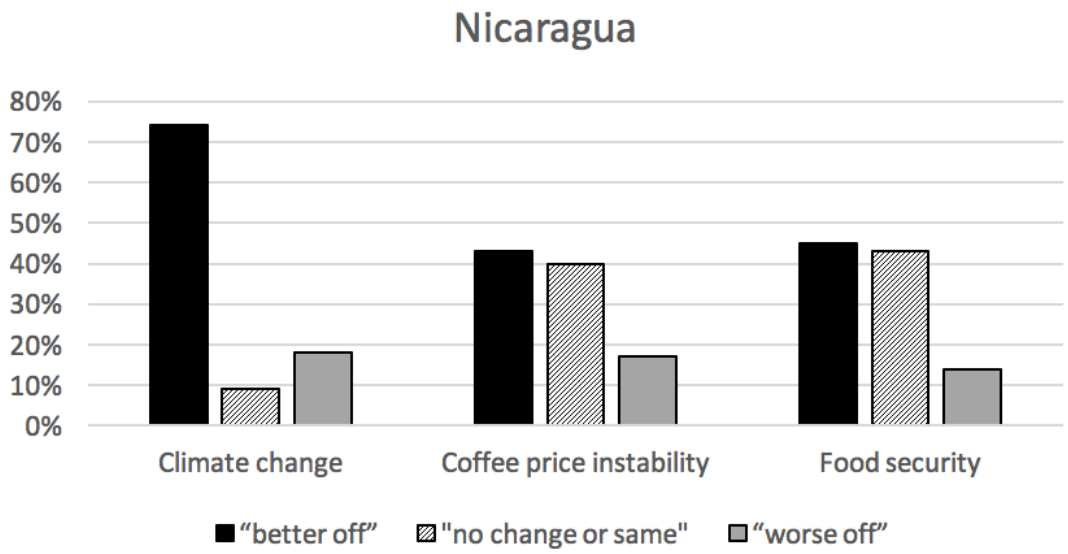
Table 11 continued. Combined summary of reported shocks, stresses & responses from surveys (n=70) and 2 focus groups (n=27).

Type of Shock/Stress (Source: survey & focus groups)	% of interviewees reporting in survey (n=70; Source: survey)	Responses (Source: survey & focus groups)
Income generation and management	N/A	■ Interplanting/diversification to include coffee, citrus trees, musaceae, papaya, etc. for additional sources of food and income and lessen dependence on coffee. ■ New crops (honey, ginger, turmeric, cacao, passion fruit, etc.) ■ Revolving credit accounts ■ Saving groups ■ Projects ■ Financing/loans ■ Work trades among family/neighbors ■ Off-farm work (increasingly needing to leave the community) ■ Adjust inputs
Food Insecurity	67% reported suffering from hunger months	■ Annual plans for food production and consumption (calculations of needs, nutrition plans, etc.) ■ Seed banks for basic grains ■ Kitchen gardens, dietary diversification ■ Improved food storage
Land Scarcity	N/A	■ Rent land ■ Intercropping
Lack of political voice	Not a survey question, but emerged as factor	■ Utilizing cooperatives and groups such as Cafenica as advocates in the system

8.4.9 Categorization of Coping Strategies

As noted above, the most frequently cited challenges from climate change were incidence of pests/disease (most frequently in coffee), and effects from drought (affecting coffee, basic grains and kitchen gardens). We used scenario/recall questions within the survey to inventory the responses to three categories of shocks/stresses identified as relevant to coffee dependent communities (namely climate change, low coffee prices and food insecurity). An adjusted version of this question was included in the focus groups. Some survey participants listed multiple coping strategies for particular threats, and/or mentioned that their actions provided short-term relief but left them either at parity or worse off in the longer term (Table 11). While there was acknowledgment by some that they felt 'more prepared to respond to challenges than they had in other moments', they also expressed concern that continuing effects of climate change are going to mean they keep having to modify their strategies to survive the 'new normal.'

Figure 11. Coping strategies for Nicaragua.



As shown in Figure 11, survey respondents reported that their coping strategies related to climate change are overwhelmingly positive – with over 3/4 of respondents reporting that their actions have left them better off than before. The majority of coping strategies in response to coffee price instability also appear to be non-erosive, however a frequent response by survey participants was 'we don't have any control over the price, so what can we do but sell our coffee?'. For those who have implemented food security coping strategies, the results were mostly non-erosive, either leaving them better off or equal to their previous condition.

As described in the methodology, we selected food security and soil health as our resilience outcome variables, and used climate change events to gauge the greatest perceived covariate shock/stress for the population (Constas et.al, 2014). No significant differences between farmer types were observed on the number of months with food insecurity (thin months), reported soil quality for coffee or major climate change related impacts (Table 12). Soil quality results are based on respondent perception, not biophysical assessments. Nevertheless, Type 1 farmers more frequently reported having good soil in their coffee plantations, and did not report having poor soils. In contrast 11% of Type 2 farmers reported having poor soils.

Major climatic impacts responses show a generalized perception, for both types of farmers, of coffee leaf rust (*roya*) and drought as the factors that have most seriously affected them in the last 3-5 years. However, there are some interesting differences in terms of perceptions of impacts from drought and coffee leaf rust. Type 1 farmers, who applied a lower number of agroecological practices considered that roya was the most severe impact they have suffered, while Type 2 farmers, who reported managing a higher number of agroecological practices reported drought as the major climate impact they have suffered.

8.4.10 Associations Among Key Variables

To determine if different factors/variables affected each other, we tested for correlations among number of thin months, perceived soil quality and climatic impacts and the variables used for classifying the farmer types (# income sources, # of plant species, total owned land, and # of agroecological practices). In Nicaragua, associations among key variables yielded some interesting results. Similarly, as in Honduras, number of months of reported food insecurity was positively correlated with the number of plant species (see Section 8.2.10 for discussion). Other interesting correlations we found were: a perception of *roya* as the most severe climate effect negatively correlated ($p<0.05$) with # of agroecological practices, which points towards a potentially positive benefit (less *roya*) of having a higher number of these practices; and perception of roya as the most severe climate effect negatively correlated ($p<0.05$) with number of income sources, meaning that those with higher income sources perceived *roya* as less of a threat. These results and expressed interest by producers in exploring diversification strategies point toward continued exploration into the benefits of both ecological and income diversification.

Table 12. Comparison of key resilience outcomes between farmer types (n=68)

		Perceived Coffee Soil Quality (% Frequency)[2]			Major Climate Impacts (% Frequency)[3]		
Farmer Type	# Thin Months[1]	Good	Medium	Poor	Roya	Drought	Other
Type 1 - smaller, less diverse	1.4	54%	27%	0%	39%	17%	22%
Type 2 - larger, more diverse	1.7	41%	30%	11%	19%	30%	19%

1No significant differences using a Mann Whitney U test; **2** No significant differences using a Chi Square test; **3** Major climate effect responses included both 'roya and drought', which were equally divided into the roya and 'Drought' categories; the 'Other' category included rain and none. No significant differences were found using a Chi Square test. See Appendix 2 for more detail.

8.5 SUMMARY OF THE NICARAGUA CASE STUDY

In Nicaragua, the majority of the survey sample was comprised of members of coffee cooperatives associated with a strong national organization (CAFENICA). This organization's advocacy and work along multiple levels of the coffee supply chain resulted in many of those farmers reporting stable coffee prices due to their membership. Although the variables we selected to classify the farmers separated them into two groups and showed significant differences, with the exception of area of owned land, this did not carry over to significant differences in the resilience outcomes we proposed (food security, soil quality and climate change impacts). Both groups reported problems with access to financing and periods of food insecurity. Given the depth of the data we were able to collect, this suggests that even though the two groups are different in some respects, they fare similarly in terms of these issues and the level of resilience they maintain. That said certain nuances require further exploration. Conducting biophysical measures of soil quality instead of relying on self-reported data could provide interesting insights around the fact that farmers who applied a lower number of agroecological practices considered that *roya* was the most severe impact they have suffered, while farmers, who reported managing a higher number of agroecological practices reported drought as their major climate challenge. Given that profit levels from agricultural activities were quite low leads to further questions around the interactions between number of income sources and financial health of the household.

In conversations with key actors about preliminary findings from the study, two themes emerged. The first was a desire to determine whether project activities are in fact contributing to resilience within these communities or whether they just represent an integrated 'business as usual' development project. One important factor with regard to increasing resilience capacities is to better understand not only what is happening (new practices being adopted, new information being accessed, etc.). but also the effects of those changes and whether they are temporary or lasting. This is examined further in the recommendation section discussing alternative approaches for monitoring and evaluation for resilience interventions.

The second, but related, theme was a desire to address individual agency as a component of resilience. Representatives from all of the implementing partners talked about the need for more education, and connections between self-sufficiency and being able to access information. The project is establishing cell phone networks of both technical service providers and climate monitors (who are tending climate stations and providing daily reports), which is facilitating better communication and knowledge sharing. However, the lack of a formal institute dedicated to coffee research in Nicaragua generated conversations about the shortage of empirical data around best practices and technological innovations that are specific to coffee production within Nicaragua.

A more thorough assessment of human assets, and social network analysis would contribute to understanding the resilience capacities and potential within these communities, but these activities were outside the scope of this study. However, an emphasis on resilience supports the desire of the implementing team to work with community members to focus on getting people to realize their own power and design their own path forward. These ideas match others from resilience literature,"...to 'expand' resilience analysis beyond descriptive analysis of the frequency and severity of unexpected shocks or the types of responses adopted within particular socio-economic groups in specific contexts, into a more nuanced analysis of the individual and collective processes that mediate people's ability to respond and adapt to such shocks." (Béné et al., 2016, p. 54).

KEY ACTOR INTERVIEWS

Off-script or on, the conversations we shared with key actors in Nicaragua were central to understanding the back-story for how LWR's local projects are specifically tailored to and interact with this context. We talked with collaborating partners by phone, over dinner and as we bumped along dusty roads. We encountered a willingness to talk with candor about seemingly insurmountable challenges, and a visible pride when the topic turned to examples of promising practices.

The strength and perseverance of Nicaraguan coffee producers and farmworkers, and the potential of the natural resource base to deliver on the reputation of Nicaragua's standard for high quality coffee, were themes that emerged from nearly every conversation.

When we asked actors to define resilience, their descriptions varied, but only in small ways. They described a capacity to weather challenges and come out on top. Referring to the perseverance of project beneficiaries, one of the consortium members stated plainly - "...they have a desire, a thirst to change."

During an interview with the coordinator of the virtual technical assistance and climate networks that are being developed as part of this project, we learned that one way that project participants are changing is by taking advantage of technology. Observations, advice and alerts are being shared by phone and it is becoming clear "...just how much information was being lost in the shuffle. And how much (technology) can cut distance and save time."

As with most promising solutions, this initiative has some constraints. Telephones and data plans for participants are currently covered by project funds, and it is unclear how those expenses will be covered for the long term. Additionally, cellular signal strength and availability are challenges for some communities. However, for now the conversations are continuing, building both social and human capital. This leaves a hopeful note that aligns with comments from another key actor, "...entre mas unidos esten, van a salir mejor de la situacion." ("The more united they are, the better they will survive the situation.")

8.6 HAITI CASE STUDY

8.6.1 Resilience Context

Haiti is the poorest country in the Western Hemisphere, with 58% of its population living in poverty (World Bank, 2016), and 53.4% undernourished (FAO, IFAD, and WFP, 2015). Just 49% of Haiti's population is literate, with a 4.9% infant mortality rate, a child labor rate of 21% (ages 5-14), and life expectancy of only 63 years (Indexmundi, 2014). Haiti's rural population has decreased representing an outflow from the countryside toward urban areas, from 60% in 2005 (IDB, 2006) to 47% in 2010 (FAO, 2016). Fifty-six percent of the country's labor force works in agriculture (or 22% of the country's population) (FAO, 2016).

Coffee is, and has historically been, an important crop for Haiti. Coffee is one of Haiti's top ten exports by both quantity and value, and the shade-grown agroforestry production system known as 'Jaden Kreyol' protects the mountain environments and generates income for over 200,000 producer families and over 80,000 seasonal harvesters (INCAH, 2015). There are coffee producing regions spread throughout the country (Eitzinger, 2013). However, Haiti's coffee production is comparatively very low and its coffee sector is not competitive in world markets. Haiti produced 0.4% of world coffee in the period from 1995-2000 (IDB, 2006), and does not rank among the top 44 exporting countries listed by the International Coffee Organization (ICO). Haiti's coffee production is nearly equal to its domestic consumption (350,000 bags produced, 340,000 consumed), compared to Nicaragua, for example, which exports 100 times more coffee than is consumed in country (2 million bags) (ICO 2015). Haiti's coffee exports have consistently fallen between 15 and 22% per year since 1996. So while coffee production plays a key role in Haiti's rural economy, livelihood diversification, and environmental conservation efforts, yields are low and export markets are not fully developed (IDB, 2006).

Coffee agroforestry is seen as an economic activity with potential to both improve rural livelihoods and prevent land degradation, but deforestation and soil erosion on steep slopes make Haitian coffee growers particularly vulnerable to the impacts of climate change (INCAH, 2015). As in other parts of Latin America and the Caribbean, increased frequency and intensity of extreme weather events translates to greater risks for agricultural producers. Haiti's average temperatures are predicted to increase by 0.9 degrees Celsius by 2020 and 1.8 degrees Celsius by 2050, and dry months are predicted to become drier with 10% less rainfall (Eitzinger, 2013). Higher temperatures and water deficits will also decrease the suitability of Haiti's lower altitude coffee farms. Suggested adaptation strategies include irrigation, agroforestry and shade management, and diversification (Eitzinger, 2013). Reforestation and reversing environmental degradation are critical to boosting Haiti's overall resilience to climate change impacts, including natural disasters.

Extreme poverty and food insecurity are chronic problems in Haiti. Fifty-three percent of Haiti's population is undernourished, by far the largest percentage of undernourished in Latin America and the Caribbean (FAO, IFAD, and WFP, 2015). Although half of Haiti's workforce is in agriculture, the country relies on imports for nearly 50% of its food (USAID, 2015). According to the World Food Program, upwards of 70% of the past year's agricultural crops were lost due to a severe and prolonged drought and recent impacts from El Niño, and if there is not rain during the spring season for 2016, farmers risk losing a fourth consecutive harvest.

Recent political turmoil in Haiti adds yet another layer of complication to an already tenuous environment. Instability at a national level not only contributes to current unrest but also complicates attempts to stabilize the agricultural sector and increase overall resilience capacity within the country. In the period after the 2010 earthquake, the Haitian government developed a National Agricultural Investment Plan (NAIP) in an attempt to coordinate relief efforts and outside investments directed toward the agricultural sector. However, implementation of this plan has been gradual, and while technology has been critical in making knowledge access and transfer more efficient, pockets of smallholder farmers still struggle to confront the systemic and environmental challenges that leave Haiti struggling both for food and sustainable export markets.

In terms of coffee, given current conditions and threats from climate change, there are calls to both support Haitian coffee producers and, in some cases, to replace coffee with other export crops less sensitive to temperature increases (e.g., mango and cacao) (Eitzinger et al., 2014). The highest priority areas for supporting coffee farmers include: providing financing opportunities, active coffee farm management including pruning, shade management, coffee plant renovation, developing processing infrastructure and supporting quality control in early stage processing, and connecting coffee farmers with export markets (IDB, 2006). Distribution of coffee leaf rust resistant varieties is another major strategy to revitalize coffee production (INCAH, 2015).

8.6.2 Project Description and Organizational Profiles

Lutheran World Relief (LWR) is working to strengthen resilience in coffee farming communities through their local partner, RECOCARNO (Réseau des Coopératives Caféières de la RégionNord, or in English - the Network of Northern Coffee-Growing Cooperatives), which is an umbrella organization for eight member coffee cooperatives that represent approximately 6500 producers (Box 5). To improve the market viability of these smaller member cooperatives, RECOCARNO serves as the link to the fair trade market in Europe and Japan; they have been registered with the Fairtrade Labeling Organization (FLO) since 1997, but despite these efforts there are still challenges to selling the coffee produced by the member cooperatives. As part of this project, financial support is being made available to improve member cooperatives and to provide technical assistance in the face of climate change and coffee leaf rust.

This is critical, because due to the *roya* epidemic and recent droughts, some smallholder farmers are abandoning their coffee plantations – feeling helpless to recover from these blows. Project goals include improving coffee production through the introduction of leaf rust resistant varieties, diversifying income through new crops or improved market chains, and reinforcing social capital by aiding local cooperative governance and function.

BOX 5: Key project facts

Title: Strengthening the Resilience of Small Coffee Producers in the face of Coffee Rust
Goal: Increase community resilience to climate change and recurrent crises affecting coffee cultivation.
Objective 1. Coffee producing families are renovating coffee plantations with coffee varieties that are more resistant to climate change, and are implementing improved production practices.
Objective 2. Families in coffee producing communities will diversify their sources of income and strengthen commodity value chains.
Objective 3. Local technical assistance capacity will be strengthened.
Objective 4. Local social capital will be strengthened.
Number of participants: 6500 members of cooperatives associated with RECOCARNO
Project duration: October, 2014 to September, 2016.
Total budget: $ 400,000

8.6.3 Key Actors

The missions of the organizations comprising the consortium for the Strengthening the Resilience of Small Coffee Producers in the face of Coffee Rust Project are outlined in Section 8.6.1 above. Table 13 explains specific roles within the project for each of the partners.

RECOCARNO sees itself as an organization focused on quality – as they say, "quality of organization, quality of product and quality of life." Recognizing the risks of small-scale coffee production as a viable livelihood for families, RECOCARNO is also working with members to consider diversification strategies to complement their coffee production. The project is now in its second year of activities. A major accomplishment in the past year was the production, distribution and planting of coffee plants resistant to coffee leaf rust (240,000 plants reported). Trainings were held on topics such as propagating coffee plants, regenerating coffee plantations, diversified crops and making compost. Model farms were established at the level of each cooperative. RECOCARNO has a group of agricultural technicians who can provide technical assistance and have been helping with the supply of disease resistant plants. Farmers consistently expressed an eagerness to gain more knowledge through technical assistance, but there are not currently enough technicians to keep up with this farmer demand.

Table 13. Key actors and their roles in the Haiti case.

Organization	Description
Lutheran World Relief (LWR)	LWR is the project's primary funder and also offers organizational assistance to RECOCARNO.
RECOCARNO	RECOCARNO is managing the allocation of funds, technical assistance outreach, and cooperative capacity building. Main activities include on site trainings with co-op members, and storing, marketing, and shipping of coffee beans.

8.6.4 Site and Family Context

In this section we present information about the site and basic demographic data on the 70 households that we surveyed during our research visit (Box 6). Participants are members of 8 distinct coffee grower cooperatives, representing over 25 communities from 5 municipalities covered by the project in the North and Northeast departments of Haiti.

BOX 6: Selected family demographics of surveyed households (n=70)

Average number of family members per household: 8.7
Average number of family members of less than 5 years of age: 1
Average number of family members of more than 60 years of age: 1
Average family members with Primary school: 87% Secondary school: 44% **University:** 30%
Average area of owned land: 1.93 ha (n=70)
Average area of rented land: 1 ha (n=5; number of households out of a total of 70 that rented land)
Average total land area: 1.49 ha.
Households growing coffee: 100%
Households growing maize: 79%
Households growing beans: 92%
Households growing plantains/bananas: 83%
Households growing yams: 72%

8.6.5 Resilience Factors

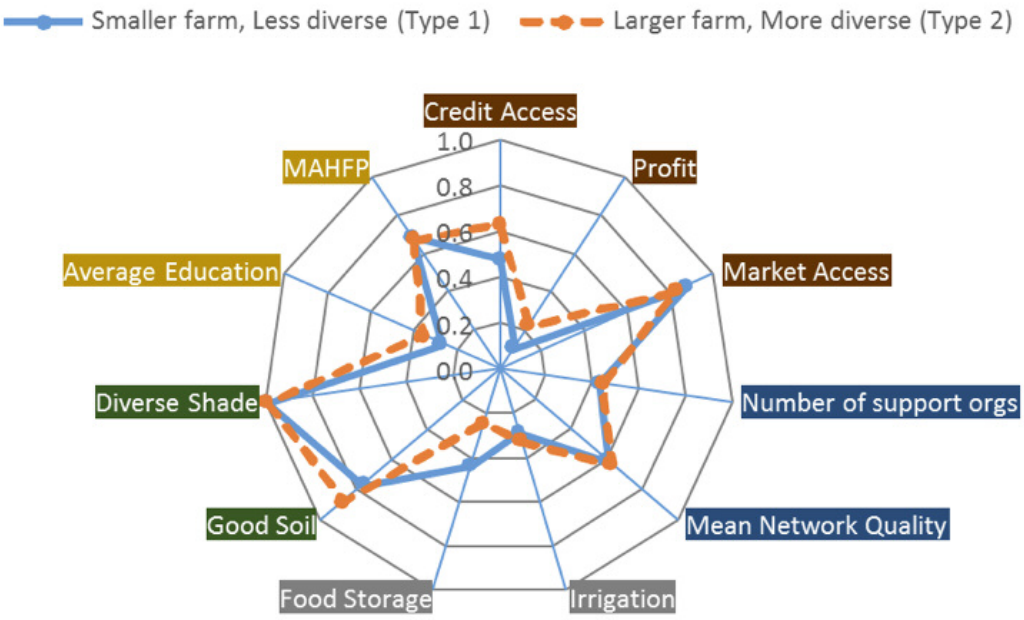
The following subsections outline general trends in livelihood asset allocation, use of agroecological practices, perceptions of climate change, coping strategies and interactions of key variables of interest with food security and soil health (the variables we selected as resilience outcome proxies). Details on how the livelihood asset categories were ranked are found in Appendix 3. Further discussion of the results is found in Section 9, which includes regional comparisons across the case study sites.

8.6.6 Farmer Typology

As mentioned in Section 8.1.1, survey responses from each country divided into two categories (typologies) where Type 1 represents a profile of smaller total area of owned land, fewer agroecological practices, lower plant diversity and lower incomes, and Type 2 represents a profile of larger total area of owned land, more agroecological practices, higher plant diversity and higher incomes. In Haiti, 42% of the households were Type 1 and 58% were Type 2. For our sample, the households from each cluster differ significantly in terms of number of income sources total number of plant species reported and total land owned. No significant differences were observed in terms of number of agroecological practices applied in their different plots.

Land holdings appear to be the greatest distinguishing factor between these groups. Type 2 farmers appear to have a slightly higher levels of resilience because they have access to more natural assets (especially more land), higher levels of plant diversity, are applying more agroecological practices and have higher levels of income diversity. In Haiti, the typical farming practice of a 'Jaden Kreyol' agricultural system means that most producers manage a multi-layered perennial polyculture system including shade canopy, mid-level fruit trees, coffee shrubs, ground cover, and vines, including plantain, citrus, breadfruit, mango, avocado, passion fruit, yam, manioc, sweet potatoes and taro. This system also provides multiple functions for the household, including cash crops, food for sustenance, fuel for cooking, wood for building, organic matter for compost, soil and water conservation and forage for livestock. Because results around income and plant diversity are also significant for our sample, a deeper analysis of the distinct income sources and types of plant diversity could provide additional clues to what differentiates the populations, but that level of detail was outside of the scope of the current study.

Figure 12. Haiti livelihood asset categories for the two types of farmer groups, color-coded, as follows: Grey=physical assets; Green= natural assets; Yellow= human assets; Brown= financial assets; Blue= social assets.



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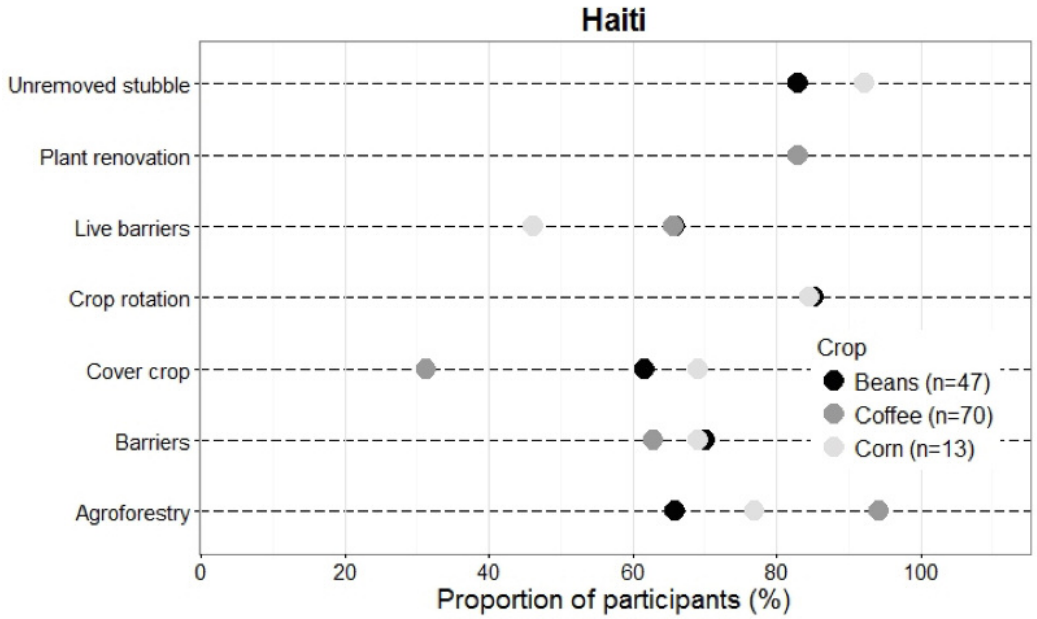
In Haiti, Type 2 respondents (larger, more diverse farms) appear to be marginally stronger in terms of shade diversity and reported soil quality, and be at similar levels to Type 1 respondents in social and human assets (Figure 12). Type 1 respondents (smaller, less diverse farms) report better access to credit, more appropriate food storage, and slightly better access to market. Both Types report very low profitability from their agricultural endeavors. Physical resources are also lacking, coffee-processing infrastructure is insufficient, there are no buildings for churches and schools, roads and irrigation systems are poor or non-existent, and access to potable water is inconsistent.

Figure 13. Most frequently mentioned agroecological practices in Haiti, applied by crop.



Haitian farmers utilized an impressive array of agroecological practices (Figure 13), with 60% applying 7 key practices across almost all of the crops surveyed, the highest of all three countries. Since some of the new varietals that are being distributed as climate resistant options are considered to have less desirable taste profiles, quality control from harvest through processing is considered even more crucial. This means that continued application of improved production practices is essential and the role of technical assistance remains critical.

8.6.7 Farmer Perceptions of Climate Change Impacts

When survey participants were asked how they had felt the effects of climate change in the past five years, they offered a range of responses from pest and disease pressure to crop loss (Table 14). However, drought was, by far, the most cited climate change related stress reported by farmers. Coffee leaf rust and drought severely affected coffee plantations, and drought effects on beans were reported more often than with other food crops.

Table 14. Perceived shocks/stresses attributed to climate change by survey participants (n=71)

Shock/stress	% Surveyed Farmers that Mentioned this Effect
Drought	87
Coffee leaf rust	6
Other or no response	7

8.6.8 Farmer Coping Strategies/Responses to Climate Change

Table 15 presents a combination of responses about shocks/stresses and coping strategies gathered through open-ended survey questions and from the focus groups. Some of the responses presented below are strategies that farmers are already implementing, while others are ideas about how to cope in the future. Most families (88% of those surveyed) experienced some months of food insecurity (usually between May and September). The most common responses to periods of food scarcity were borrowing money, selling livestock or other farm products, and conducting micro-commerce (buying goods in bulk and selling portions in local markets). While more respondents indicated that these actions allowed their families to keep holding on, almost as many said that these responses placed them in a worse situation than before, often because of the obligation of paying back high interest loans (2-3% per month).

Table 15. Combined summary of reported shocks, stresses and responses reported in surveys (n=73) and four focus groups (n>53).

Type of Shock/Stress (Source: survey & focus groups)	% of interviewees reporting in survey (n=73; Source: survey)	Responses (Source: focus groups)
Drought	96%	■ Most farmers had no response to drought ■ Irrigating small market gardens by hand ■ Planting shorter season crops ■ Planting trees to change microclimate
Coffee Leaf Rust	99%	■ Removing affected branches and trees ■ Renovating plantations with resistant varieties ■ Some cooperatives reported technicians trialing fungicide treatments
Food Insecurity	88%	■ Borrowing money ■ Sell livestock, other produce, or lumber ■ Micro-commerce

Table 15 continued. Combined summary of reported shocks, stresses and responses reported in surveys (n=73) and four focus groups (n>53).

Type of Shock/Stress (Source: survey & focus groups)	% of interviewees reporting in survey (n=73; Source: survey)	Responses (Source: focus groups)
No Money (for school, farm labor, etc.)	Reported in focus groups	■ Borrowing money ■ Selling livestock, other produce, or lumber ■ Micro-commerce
Political Violence	Reported in focus groups	■ Emigration
Hurricanes	10%	■ Most had no response ■ Soil conservation, planting trees

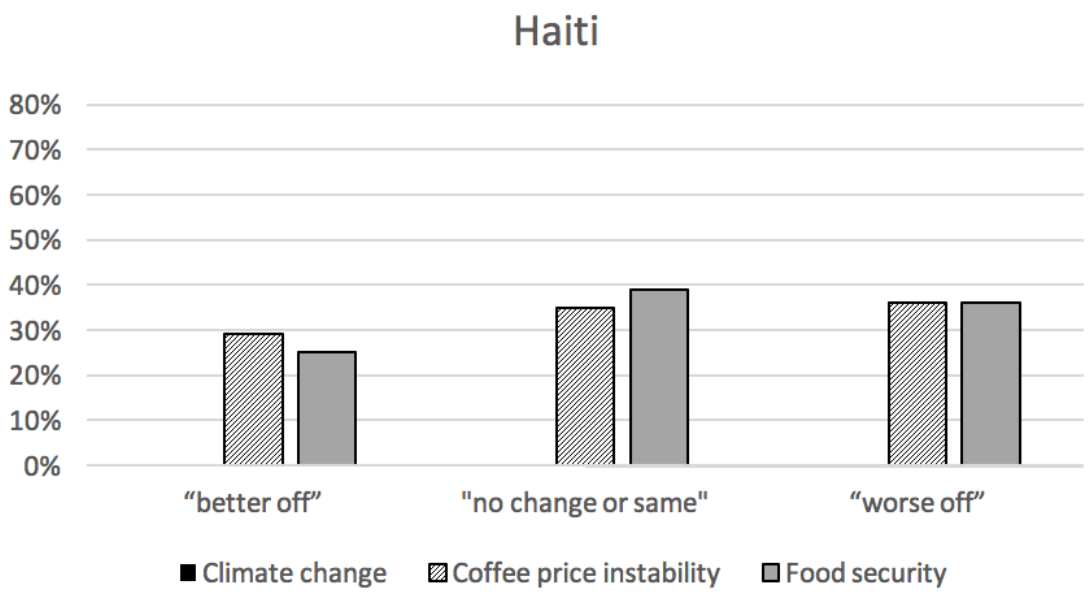
While the cooperative wide efforts (in some locations) of producing and distributing rust resistant seedling to member farmers have not yet yielded results in terms of harvested coffee, this strategy seems to have the most promise for long-term success, and appears to merit more follow-up and resources. Credit for agricultural investment or micro-commerce is desired by the farmers, but needs to have a high return on investment potential to offset high interest rates currently available. Low interest loans and rust resistant coffee plants were the most commonly expressed desired response. Even though interviewees rarely mentioned it, procuring a higher price for coffee sold through the cooperatives would provide relief. Almost all reported selling their coffee through the cooperative no matter the price, and many reported utilizing various coping strategies to compensate for insufficient earnings from their cash crops.

It is important to mention that some of the shocks/stresses discussed dealt with structural issues such as political violence, with leaving (emigration) cited as the only potential response. In subsequent conversations with key actors, the impact of a dysfunctional government and the influx of development initiatives with no central coordination was mentioned as an additional complicating factor.

8.6.9 Categorization of Coping Strategies

An adjusted version of this question was included in the focus groups. When asked what coping strategies were used, the overwhelming response for climate change was 'nothing', or no coping strategies– both for drought conditions and to combat coffee leaf rust- (that is why there is no bar present for this category in Figure 14).

Figure 14. Coping strategies for Haiti.



Those who were able to water their vegetable gardens by hand, because of a proximity to a river or spring, observed positive results. The minimal number of coping strategies identified for the climate change section from the Haiti surveys was not sufficient for statistical analysis (thus they are not included in Figure 14), but the responses collected represent a sentiment that producers were only maintaining status quo with interventions against coffee leaf rust (pruning, foliar sprays, etc.). It is hard to know whether the doing nothing is more a signal of hopelessness or a need for more knowledge about potential solutions – this merits further investigation. The responses provided by survey participants indicate that erosive coping strategies are more prevalent than in the other countries. Over 1/3 of respondents reported that their responses to food insecurity and coffee price instability were leaving them worse off, which indicates a path toward greater vulnerability and even more urgency for building resilience capacity in these communities.

8.6.10 Interactions with Resilience Outcome Variables for Identified Farmer Types

As described in the methodology, we selected food security and soil health as our resilience outcome variables, and used climate change events to gauge the greatest perceived covariate shock/stress for the population (Constas et.al, 2014). No significant differences between farmer types were observed on the number of months with food insecurity (thin months), reported soil quality for coffee or major climate change related impacts (Table 16).

While perceptions of soil quality were generally high, to more accurately analyze interactions among these variables would require biophysical assessments of the natural resource base, which we were not able to conduct for this study. That said, Type 2 farmers more frequently reported having good soil in their coffee plantations, and did not report having poor soils. In contrast 5% of Type 1 farmers reported having fields with poor soils. Major climatic impacts responses show a generalized perception, for both types of farmers, of coffee leaf rust and drought as the factors that have most seriously affected them in the last 3-5 years.

Table 16. Comparison of key resilience outcomes between farmer types (n=71).

		Perceived Coffee Soil Quality (% Frequency)[2]			Major Climate Impacts (% Frequency)[3]		
Farmer Type	# Thin Months[1]	Good	Medium	Poor	Roya	Drought	Other
Type 1 - smaller, less diverse	3.13	77%	18%	5%	7%	87%	6%
Type 2 - larger, more diverse	3.27	88%	12%	0%	5%	88%	7%

1No significant differences using a Mann Whitney U test; **2** No significant differences using a Chi Square test; **3** Major climate effect responses included both 'roya and drought', which were equally divided into the roya and 'Drought' categories; the 'Other' category included rain and none. No significant differences were found using a Chi Square test. See Appendix 2 for more detail.

8.6.11 Associations Among Key Variables

To determine if different factors/variables affected each other, we tested for correlations among number of thin months, perceived soil quality and climatic impacts and the variables used for classifying the farmer types (# income sources, # of plant species, total owned land, and # of agroecological practices). One interesting finding from this analysis was a negative significant correlation ($p<0.040$) between farmers reporting 'bad soil' and number of agroecological practices used. This points towards the possibility that those with more agroecological practices have better soil. However, testing this would require more in-depth ecological investigation. No other significant associations were found among variables. These analyses reinforce the need for a deeper exploration of how agroecological practices may be affecting rust, drought conditions and soil quality on the farms of the different farmer typologies.

8.7 SUMMARY OF THE HAITI CASE STUDY

From our survey and focus group work in Haiti, it is clear that coffee farmers are under duress from reduced production due to drought and coffee leaf rust. Lower production levels for both cash and subsistence crops are resulting in food insecurity and a lack of cash flow for normal living expenses. Although the variables we selected to classify the farmers separated them into two groups, and showed significant differences, this did not carry over to significant differences in the livelihood outcomes that we associated to resilience (food security, soil quality and climate change).

Insufficient financing and a lack of consistent markets were also cited as key vulnerability factors for Haiti, and despite articulated desires for improved organizational capacity (primarily associated with administrative and technical assistance functions), the communal spirit observed in Haiti is a clear asset with potential for contributing toward future improvements in resilience capacity. Farmers appear eager to learn more and improve practices, and communities are already engaging in both formal and informal trade networks. The environment seems ripe for farmer field schools and other knowledge exchange models to respond to the lack of more formal technical assistance. Capitalizing on the experience of the other LWR projects focused on coffee offers an opportunity for a farmer to farmer learning exchange, where Haitian farmers can discuss their extensive use of agroecological practices and farmers from Nicaragua could discuss their experience/recommendations in terms of the newer varietals. Honduran farmers would likely also benefit from joining in and talking with more experienced farmers, and shared conversations about cooperative models and market opportunities would be beneficial to all.

The farmers are clearly dedicated to continuing in coffee production and value the relationships they have both with their base level cooperatives and RECOCARNO. They spoke with pride about the governance and transparency of these organizations but, despite their local capacities and enthusiasm, these communities are in need of external support for access to financing and connections to stable supply chain partners if they are to continue in coffee production. Market solutions and strengthening value chains are strategies that are central to this resilience project, but there appear to be formidable barriers to resolving these issues quickly (including export processes that are complicated and costly), and the uncertainty of what if any support will be ongoing (from government or NGOs) leaves these communities in an uncomfortable position of limbo. RECOCARNO would benefit from external support in developing and executing a comprehensive plan for marketing the coffee of its member cooperatives.

FOCUS GROUPS

The meeting with the fourteen men and women coffee farmers in the small mountain community of Bouk a Michel, started with a prayer and an inspirational Kreyol hymn. After introductions, the participants organized into small groups, each supplied with a long sheet of paper and colored markers. They spent an animated half hour detailing in calendar form the seasonal activities in their coffee plots and other crops, how their food stores fared throughout the year, and the 'typical' climate patterns that they farmed by.

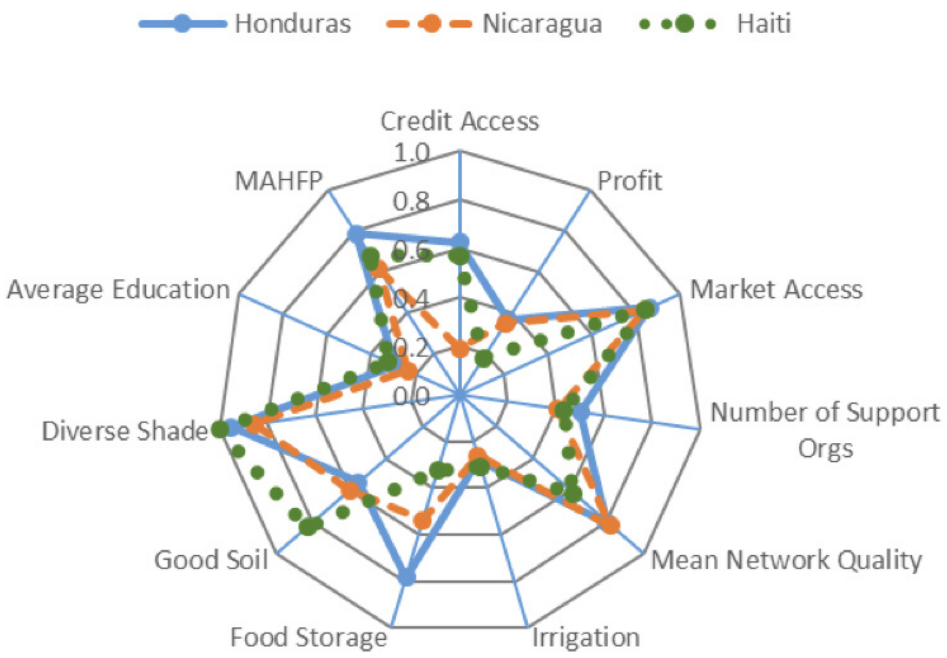
Participants overlaid each calendar on the wall and reported back to the group. We marveled at the richness and depth of the knowledge and information that came together in this format and the elegance of their food and farming systems. Next, we asked the farmers to write on sticky notes the different shocks and stresses that occur in their community and place them on the calendar. It was heart wrenching to see the notes appear about prolonged drought, children dying from cholera, houses burnt in election violence, hurricanes, and diseased coffee plants. Yet, here they were enthusiastically participating in our exercise. Talk about resilience.

As we moved papers around to set up the next exercise, a spirited work anthem broke out from the smiling and clapping farmers. They sang, "Cooperatives are a way for people to manage their resources…". We knew that social capital was a source of strength here in Haiti, but this solidarity song really drove it home. The orange sticky notes denoting strengths piled up in the social, human and natural resource circles, and the blue sticky notes for vulnerabilities filled the financial and physical infrastructure circles. An intense discussion followed on how to move from positions of vulnerability to strengthen resilience. The women's voices were especially strong and clear, "access to credit, a better school, a health center, disease resistant coffee plants…"

9. DISCUSSION AND CONCLUSIONS: CROSS-SITE ANALYSES

9.1 COMPARISON OF LIVELIHOOD ASSETS AMONG COUNTRIES

Based on the significance of asset allocation to resilience capacity, We took survey results and graphed them to be able to better compare across sites, which provided some sense of regional trends and particularities by site.. We then compared these graphs with results from qualitative data gathered through interviews with key actors and during focus groups in each site. In this section we present the same livelihood asset variables and categories as found in each case study, but the spider graph below incorporates data from all the farmers surveyed (Figure 15). This allows for a cross-country comparison by asset, in the following sub-sections.



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9.1.1 *Natural Assets –*

In Haiti, the strength of the natural asset category seems to partially come from the place coffee holds as a type of 'keystone species'[3] within the shade-grown, perennial polyculture system. Respondents in Nicaragua and Honduras, on the other hand, report 'tierra cansada' or worn-out land that is a combined result of deforestation and soil degradation. We were able to undertake only a few site visits per country, resulting in little opportunity to collect and analyze biophysical evidence from farms. However, despite these limitations in our data, trends that we observed across all sites included decreasing yields (both as a function of recent damage from *roya* and other pests/diseases, and the production lags that accompany the intense renovation of coffee plots that are currently in progress), increasing costs of production, and questions about future suitability of coffee given climate predictions. The reports align well with the agroecological literature, which argues that the agroecosystem diversity and similarity to the natural ecosystems (in this case multi-strata forests) of a given region, in the Haitian case, will better maintain ecological properties and processes (Gliessman, 2015). We would expect similar trends in Nicaragua and Honduras, and more detail is necessary to fully understand what fields people were referring to as 'tired'. In most coffee areas, fields used for annual crops (i.e. maize and beans) tend to be more constrained, as the steep slopes, combined with less cover (especially of perennial plants) will usually result in erosion and nutrient depletion. In our literature review to determine agroecological practices with links to increased resilience, diverse shade management continues to stand out as the most promising practice, with links to improved soil health and pest and disease suppression (if accompanied by the right form of management; see Appendix 1). The importance of reforestation was also mentioned by key actors and in focus groups in all three countries.

9.1.2 *Physical Assets –*

We placed our focus on the assessment of physical assets that were associated with household agricultural or income-generating activities. We did not include survey questions that had to do with housing type, or supply chain infrastructure, but these topics emerged during the focus groups and in key actor interviews. Since drought has been one of the primary threats to producer livelihoods in recent years, both water storage and irrigation systems are an indication of adaptive capacity. In both Honduras and Nicaragua, over three-quarters of households reported having some capacity for water storage, whereas in Haiti just over one-third reported similar infrastructure. Only a fraction of households reported any irrigation beyond hand watering, with just over a quarter in each country responding affirmatively to survey questions about on-farm irrigation systems. In Honduras and Nicaragua, where food storage infrastructure has been an area of focus (either through projects from NGOs or governmental interventions), respondents mentioned improvements in options and fewer post-harvest losses. In Haiti, however, most farmers store dry beans (both for food and future seed) in sacks within the house, and report high levels of loss from insects and other pests.

3 Keystone species play a key role in many ecological communities by maintaining the structure and integrity of the community, many times through its influence on the survival of other species (Wagner, 2010).

9.1.3 Financial Assets–

Overall, fewer than half of the respondents to our survey reported profitability from their agricultural activities. This is of concern for two reasons: 1) costs of production, associated with increased pest and disease pressure, are rising; and 2) market prices for coffee have stayed relatively low. Results for access to credit and profit are mixed; where credit is available, the interest rates are often high, and it was reported that loans are taken out of necessity (covering costs for inputs/labor) more than out of choice (decisions to make investments). In Honduras, concerns around finances had more to do with financial management skills than with access to loans. Reported access to financing options was especially low in Nicaragua, where there is a perception that much of the investment dollars have been directed toward the larger coffee estates instead of reaching smallholder farmers. In Haiti, access to credit is crucial for the diversification strategy of 'ti komes' or buying and reselling of goods; without the initial cash infusion to purchase goods, there is no hope of generating income for the household. Haitians noted that lack of credit was a limiting factor in terms of their ability to increase their household resilience.

The access to markets data from Figure 14 can be slightly misleading at first glance, since it gives the impression that all sites have essentially equal access to markets. In Nicaragua, the farmers we surveyed are members of producer organizations (cooperatives) that have fairly reliable contracts with exporters, all of whom sell at least a portion of their coffee under fair trade or other certification labels. In Honduras, reliable access to markets is through intermediaries (coyotes) who offer the advantage of cash up-front, but often pay lower prices and provide no other support or technical assistance. In Haiti, farmers are able to sell their harvest to their local cooperatives facilitated by a strong relationship with the allied cooperatives that comprise RECOCARNO, but RECOCARNO is struggling to find external markets for their coffee. Producers mentioned that financial help comes in the form of projects (which provide micro-loans) and premiums - each providing benefit to the producer, but often indirectly and inconsistently, and not necessarily in the greatest moments of need.

9.1.4 Social Assets –

The design of our study meant that data on social assets emerged more from focus groups and in conversations with key actors than from survey data. However, data on the number and quality of relationships gathered in the surveys provided important signals about the presence and strength of support networks for the target populations. Resource limitations meant we did not specifically ask about informal networks, which is a priority area for any future activities given that, "...informal social interactions are communities' best resources for maintaining their capacities to build social resilience and to change collective direction" (Pelling and High, 2005 in Keck 2013). This omission is especially notable for Haiti, where community cohesion and 'konbit' (collective work) are not represented in quantifiable terms but occupy a critical position and hold great influence. When asked, 'who do you turn to in time of crisis?' in Honduras, 83% of respondents said that an NGO (most often OCDIH) was their most important/reliable source of support; in Nicaragua, 48% said their cooperative, and 43% said an NGO (Cafénica and CIEETS were mentioned most often); and in Haiti, of those who answered, 75% said either RECOCARNO or their base cooperative, followed by NGOs (13%).

In each site, occasional mention was also made of family, church and school. These survey results align with the opinions of key actors in each of the three countries who were asked what level of support external players provided in moments of crisis. Reinforcing the responses of the coffee producers/farmworkers, key actors mentioned the important role of the coffee cooperatives and both local and international NGOs. Notably, there was either no or very little mention of government intervention and/or support from international players along the coffee supply chain.

The findings that highlight the importance of local/producer organizations, align with a recent report mapping the influence of social actors in relation to climate change and agriculture in Central America, representing the disparity between perceived support/relevance in times of crises. This study noted that in Honduras, at a national level, governmental ministries, USAID and agencies associated with the United Nations were perceived to have the most influence, whereas at a local/regional level, actors from the governmental, NGO, academic and private sector were all mentioned. In Nicaragua, the national government (particularly the executive branch, but also the department of agriculture) was considered most influential, while at the local/regional level NGOs closely followed the ministry of environment and natural resources. Unfortunately, Haiti was not included in the study (Castro Colina et al., 2016). As development organizations consider their role in building social assets (both bridging and linking), this kind of stakeholder mapping and/or social network analysis will prove important.

9.1.5 Human Assets –

Educational data represents only formal education levels, revealing very low attainment for this category in each country. Our study did not include any metrics for gauging practical expertise related to agricultural endeavors. However, even though we did not measure it, we heard repeatedly that climate change is changing the usefulness of accumulated, historical knowledge of farmers; in other words, the changing climate is requiring new knowledge on top of the lessons extracted through trial and error over the years, and from 'knowing' how to farm in a particular site (Panhuysen and Pierrot, 2014). For example, erratic weather patterns are interrupting the rules of thumb that have previously been followed to set planting/harvesting dates and guide other activities. Farmers commented that they are unsure of what to do when knowledge that has allowed them to make decisions in the past, seems to be inadequate in the present. Unpredictable periods of drought and off-cycle rains are affecting workloads, leaving blocks of 'waiting time' and then periods where delayed work from one crop impacts the ability to initiate work on another. This introduces questions around how to support farmers in learning/developing new strategies, and reinforces the need for any and all strategies to be adaptable. In Haiti, the lack of cash flow from failed coffee crops has been so severe as to prevent some families from sending their children to school – an effect that carries forward if those students do not return to school, potentially decreasing educational levels of a household, if those students do not return to school.

Most farmers we spoke with appreciated the recommendations of using agroecological practices, as they perceive the benefits to be real and lasting, but an alleged disadvantage was that these practices are often more labor intensive. In the face of these challenges, Nicaragua offers a success story in terms of innovations and acquisition of new skills. The climate stations (where farmers in select geographies within the primary coffee producing regions are taking daily readings on a set of temperature, humidity and precipitation readings) are providing hope that soon there will be more accurate and more available climate data for coffee farmers. It also represents a mastery of new skills as the farmers who are managing the climate stations have become proficient at new technologies in order to carry out their project responsibilities. For now the climate data is not changing on farm practices and therefore outcomes, but the level of engagement shows a belief that the knowledge gained about climate will help inform smarter decisions in the future. A success, representing careful project design, is that farmers appear to be able to fit in these extra activities without much interruption to their ongoing farm management responsibilities.

Additions and/or substitutions of household activities, usually in conjunction with livelihood diversification strategies also have labor implications, especially in terms of distribution of workload among the members of the household. This indicates the need to consider power/gender dynamics when new activities are being proposed. Most respondents were open to the idea of diversification and saw value in options, but shared that they preferred to be able to choose what to pursue, instead of being invited to participate in 'pre-baked' projects, especially when these require investment of their own time/resources toward yet 'unproven' ends. The implications of this for project design are two-fold. First, following the use of differentiation of the target population, which in our case we did through typologies, interventions could be different for each one of the identified groups. In our particular case, farm size was a bigger constraint for one of the groups, so this should be taken into account when identified and planning for interventions. Second, this is not just about engaging farmers from the start, but also building in flexibility and choice along the way for project beneficiaries, which is sometimes challenging within mainstream development funding mechanisms. Because they were not a component of all three projects, seed banks are not represented in the physical assets list, but in Nicaragua the seed banks accessed by the population of farmworkers were mentioned as a critical resource for those families.

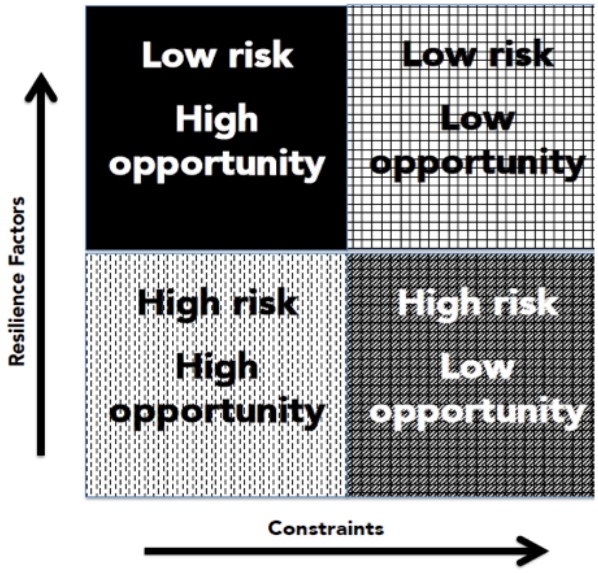
A final and intangible component of human assets that we observed in each country is perseverance. This characteristic is not reflected in the spider graphs because of the challenge of quantifying it, but a resilience assessment is incomplete without considering and capturing people's persistence to carry on. In each case study site, we observed fatigue and frustration, but not defeat. An example of this is Haiti's communal society where social capital and cooperation are highly valued and prioritized. The farmers there spoke of a time before the RECOCARNO cooperatives, when they had no choice but to sell their coffee to 'speculateurs'. They now speak with pride about the governance and transparency of the cooperatives and that, even more than the price premiums, they value working together as they believe it helps them to overcome obstacles.

9.1.6 Political/Cultural Assets –

Although survey questions did not solicit responses directly related to political or cultural assets, these categories surfaced as important factors either in focus groups, key actor interviews or both. Recent political turmoil in Haiti and Honduras, and upcoming elections in Nicaragua are critical considerations and a reminder of the inextricable tie between political context and resilience capacities. Though asset levels are critical to understanding the relative position from which individuals are operating, we must also consider "… all those societal factors that both facilitate and constrain people's abilities to access assets, to gain capabilities for learning, and to become part of the decision-making process" (Keck, 2013 p9).

9.2 TYPOLOGIES AND RISK/OPPORTUNITY PATHWAYS

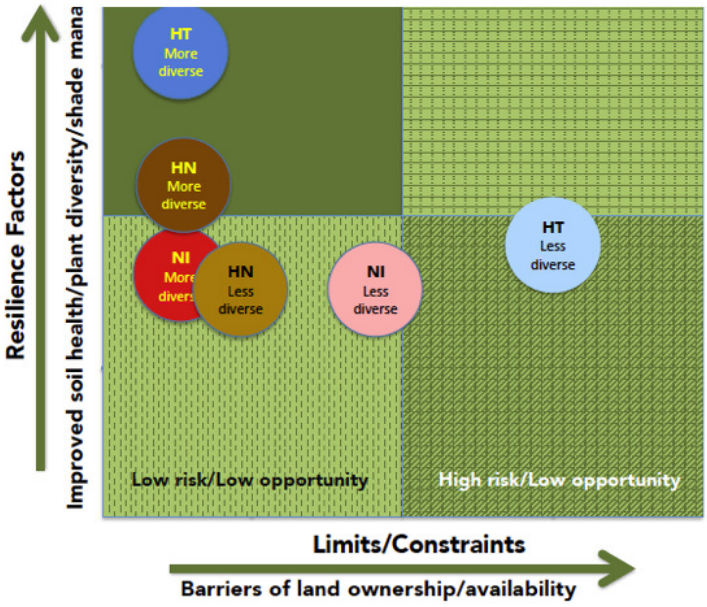
Figure 16. Risk/Opportunity Matrix.



We developed qualitative matrices as a visual way to represent resilience and vulnerability pathways. In this case the 'ideal' position, based on considerations of risk and opportunity, would be the upper left quadrant (Figure 16). A description of how we positioned each of the groups in the quadrants is provided in Appendix 4. The subsequent figures demonstrate both where the cluster types fall by country, and in relation to one another. Despite the fact that our clustering of survey respondents represents a static point in time, based on a limited set of variables, the contextualization of their current position provides important information when considering appropriate future interventions for resilience. However, acknowledging the multiple elements and feedback loops acting on and within these communities, any future position could represent either gains or losses in any of these areas. Changes are inevitable, both as functions of development interventions and the lack thereof. Subsequent sections address the relationship among various resilience capacities and LWR interventions, shedding additional light on both the observed and predicted trajectories of these populations.

9.2.1 *Agroecosystem Risk/Opportunity Matrix*

Figure 17. Agroecosystem Risk/Opportunity Matrix.

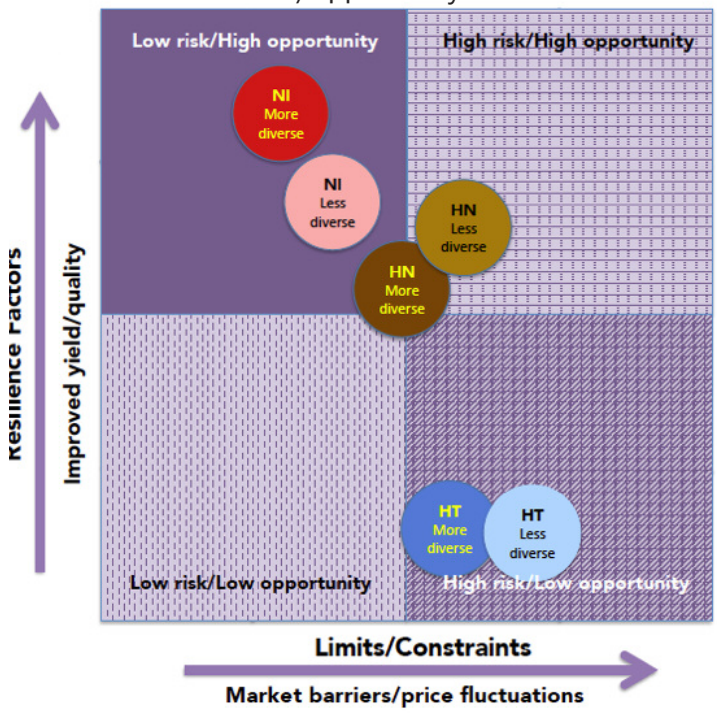


Agroecosystem integrity is strengthened by diversity and a high number of interrelationships among components (Gliessman, 2015). In other words, a desirable farm profile is one that has sufficient elements to preclude that any single component is essential to overall performance (Cabell and Oelofse, 2012). Land availability and productivity are critical factors to farmers of all types, and even more so to producers of perennial crops like coffee, who cannot simply rent new land each year to cultivate their crop (newly planted coffee typically takes three to five years to start producing). Relative positioning of the countries and clusters in this matrix is based on data from the survey, including land holdings, land tenure, use of agroecological practices and plant diversity (Figure 17). This was combined with qualitative data from the focus groups and key actor interviews. The production of coffee has been a positive factor in the maintenance of biodiversity in many regions (Jha et al., 2014); essentially the only forested regions left in Haiti are shaded coffee plantations. Given the positive ecological interactions of a low-input, perennial polyculture system, Haiti's coffee-dependent communities benefit from a strong position of ecological resilience of their production systems.

That said, our field team perceived a lack of understanding of ecological interactions, by farmers, which could be a limiting factor when making management decisions. It is important to note that without coffee, these Haitian farmers would have less interest in planting and maintaining the trees that anchor their rich ecosystem; for the most part, the other crops they grow can be cultivated in full sun. Access to land makes for the greatest difference between the two groups of Haitian farmers. In contrast, while Honduran farmers have greater availability of land, they reported lower soil quality and have less plant diversity, partly because of a historical pattern of deforestation and mono cropping. Nicaragua is also experiencing the negative consequences of deforestation, most of which is occurring in the areas surrounding coffee production. This causes erosion, changes in soil moisture and quality, and other effects within coffee dependent communities. Nicaraguan and Honduran respondents reported landholdings that were both owned and rented, typically with perennial crops on owned land and subsistence crops on rented parcels. An accompanying challenge to this split in both countries was that there is little incentive to invest in improving soil on rented parcels, leaving farmers to cultivate their basic grains in 'tired soils.' This is especially problematic for the farmworker population, who often need to take out loans to rent the land for their basic grains

and then are doubly indebted if they experience crop failure, which in turn often leads to further indebtedness from seeking additional loans to purchase necessary food. Vulnerabilities and risks that might diminish position include soil degradation, increased pest and disease pressure, continued deforestation, extreme weather events, etc. Resilience interventions that might improve positions include the use of agroecological practices that can address multiple factors (including a focus on shade and soil management). Again, adequate shade management (agroforestry) is a tested practice to maintain the integrity of the agroecosystem, although sometimes it might decrease coffee or other crop yields. The matrices could be useful to track the effects on resilience or vulnerability pathways of specific interventions. For example, if we have a population positioned in the lower left square of the agroecosystem condition matrix, a project focused on improving shade management would be a potentially relevant intervention for Type 1 farmers from Honduras (the brown circle above). After initiating these activities, you would hope to observe the cohort making vertical progress toward higher natural resilience capacities. This kind of monitoring and evaluation techniques require an analysis of correlated factors (i.e., shade management, soil quality, etc.) in order to determine if and how broader projects that address multiple factors have an effect on moving the population towards resilience or vulnerability positions over time. This approach could be incorporated into any of these projects, and could benefit from collaborations with researchers/academics that could support data collection and analysis.

Figure 18. Coffee production risk/opportunity matrix.



9.2.2 Coffee Production Risk/Opportunity Matrix

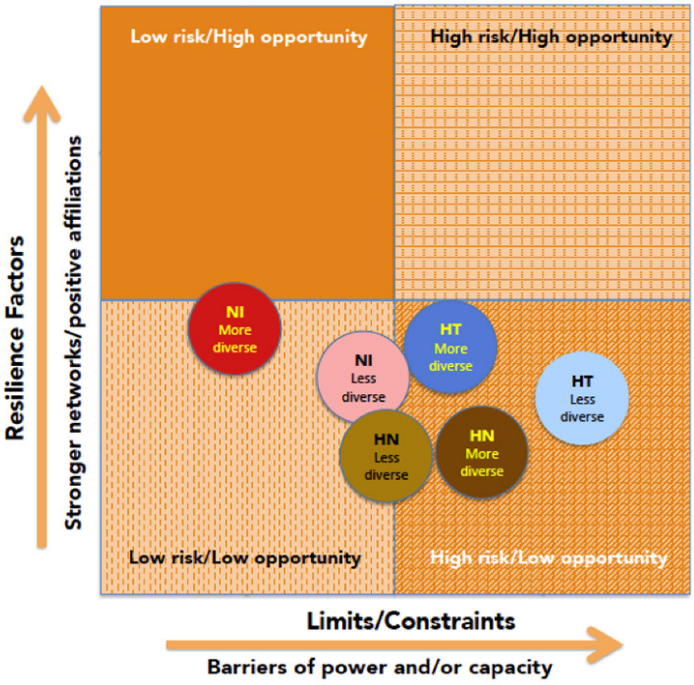
As producers continue to pursue price premiums in order to earn a profit on their coffee, or at least increase their earnings, quality appears to be the area of greatest focus. This is especially true in Nicaragua, where even though many producers are already in the fair trade, organic market, they are still trying to do all they can to influence factors of yield and quality; even when they feel completely disenfranchised when it comes to pricing. Questions abound regarding how the new varietals will 'cup', and farmers are experimenting with intercropping among traditional and 'improved' varieties as a hedge, to garner both the promised benefits in yield, while maintaining the flavor advantages of more traditional varieties. Relative positioning of the countries and clusters in this matrix is based on coffee yield data obtained through the survey and qualitative data collected through focus groups and key actor interviews related to quality, and market (Figure 18).

The target communities in Honduras and Haiti are currently producing a lower quality coffee than those in Nicaragua. In Honduras the farmers are cultivating conventional coffee, and some at lower elevations (below 700 masl), which excludes them from organic and some specialty markets that might provide the advantage of price premiums. In recent months, there has been a lot of conversation around Cuba's unique agricultural practices, but for years Haiti has also been in its own 'special period' resulting in a wealth of low-input, agroecological practices and almost exclusively organic coffee production (there are virtually no agrichemicals or fertilizers available on the market). However, in the last two growing seasons, Haitian coffee harvests were reduced as much as 90% due to drought and roya, with a large proportion of plants dying out and some parcels being abandoned.

Vulnerabilities and risks that might diminish position, in both Honduras and Haiti, include producers having fewer or weak ties to buyers and other farmers as related to the possibility of organizing. In addition – across all three countries – farmers who are located at lower elevations are at higher risk for the 'unsuitability' of their location for coffee production in a warming climate, other severe pest/disease outbreaks, adjustments in production practices associated with new varietals (e.g., do they require different approaches to pruning, how long do they last in storage), and problems with quality associated with new varietals. These could all lead to a slip in resilience positioning associated specifically with coffee production. Resilience interventions that might improve position include continued testing of varietals, enhancing and expanding use of agroecological practices, such as improving soil health and shade management that are associated with greater yields, and improved links to solidarity buyers.

9.2.3 Information and Support Risk/Opportunity Matrix

Figure 19. Information & support risk/opportunity matrix.



Both the sustainable livelihoods framework and some resilience frameworks have been criticized for their lack of attention to issues of power and agency when assessing resilience capacity, as the 'system' is often assessed apart from the role and potential of the players (Bene et al 2012; Keck, 2013). Our study was not able to take on these topics with the depth that they deserve, highlighting an area worthy of future research and investment. However, as these are contextual layers that have direct connection to the effectiveness of potential interventions, it is important that they are addressed with the information available (Figure 18). The majority of coping strategies from Nicaragua were reported as positive/non-erosive mechanisms,

Honduras reported about half positive and half neutral (neither worse nor better off as a result), whereas in Haiti the majority of responses were neutral to negative/erosive. The relative positioning of the countries and clusters in the following matrix is based on organizational affiliation data obtained through the survey and qualitative data collected through focus groups and key actor interviews related to gender dynamics, perceived political agency, coping strategies and informal social networks (Figure 19).

In Honduras, the Maya Chortí, are a previously oppressed population, having only received official recognition of their community by the Honduran government, and access to land, in 1996. These communities are still somewhat isolated, and receive limited support from both government and non-government agencies. Their relationship with OCDIH is very strong, but for most households this is the only connection they reported. In addition, they have limited links to networks on coffee markets and quality support at the international level. A recent relationship with the exporter OLAM is a step in the right direction. An additional source of support, which relates to cultural capital, is the Maya Chortí organization CONIMNCHH, which provides a diversity of networks and helps to maintain a strong and vibrant indigenous culture and identity.

In Nicaragua, though both small-scale producers and farmworkers feel disenfranchised by governmental politics, local organizations are seen as strong and are appreciated. Until now, the population of farmworkers was fairly stable – leaving during harvest but remaining fairly close to home and returning to their subsistence farming afterward. Family emerged as a strong unifying and motivating force, with focus group members mentioning that even if they do not live to see the changes, they want to work on improving their situation for the benefit of their children. Current challenges, ranging from drought and roya to low coffee prices, put this population at risk of family members going farther afield, which they worry will erode some of the strength of their existing social networks. Coffee farmers in Nicaragua, on the other hand, are benefitting from the relative strength of the cooperatives and organizations like Cafenica, who have both international reach and recognition.

Though there are few official organizations supporting the target population of coffee farmers in Haiti, the population's clear strength comes from their communal society, including their traditions of community work exchange and openness to collective problem-solving (tet ansam). Though the threats and challenges to this population are formidable, their interdependence puts them in good position to collectively respond to systemic/external barriers. Recent election turmoil reinforces the limits both to expectations and capacity for meaningful government support in the short-term. Though the cooperative members are very appreciative of the supports and services provided by these groups, more reliable relationships with buyers and better prices are two requisites for a viable future in coffee for these farmers.

Vulnerabilities and risks that could diminish position for any of these groups include continued political turmoil, marginalization within civil society, lack of political voice and interrupted funding for resilience work. Resilience interventions that might improve position include continuing to build supportive networks and investment in foundational work to improve individual household and organizational agency (both confidence and competence) around articulating a path toward resiliency. That is to say, investing in activities that build human capital so that the resilience efforts are not only tied to external activities, but are also improving the internal belief in their own capacities. This dual focus at both individual and organizational levels is important since resilience is "...strongly influenced by social and individual self-perception, norms, values and self-confidence in people's ability to handle future events." (Bene, 2016 p. 155)

9.3 COPING STRATEGIES

Most recent resilience frameworks for development work categorize responses to shocks and stresses into three categories – absorptive capacities (preparing for, mitigating and/or preventing consequences), adaptive capacities (adjusting or modifying behavior to take advantage of opportunities), and transformative (significant structural changes such that there is a new system). Since one aspect of resilience is dealing with the 'unknown unknown' (Bene, et al, 2012), when assessing a population's resilience potential, it is important to examine whether they are exhibiting capacities that are absorptive, adaptive and/or transformative. In addition, it is important to gauge whether the responses are negative/erosive (leaving the population worse off than before) or positive/non-erosive (leaving the population at parity or better off). In this section we present analyses of reported coping strategies related to climate change, food insecurity and coffee price instability.

9.3.1 Climate Change

In both the survey and focus group activities, we solicited examples of the coping mechanisms that participants were implementing in the face of a changing climate. Responses included adjusting pruning practices, new fertilization and pest prevention practices, replanting areas that had old/weak/damaged coffee plants, and reforestation. This array of strategies represents a mix of absorptive, adaptive and transformative strategies (reforestation being the only one that qualified under the latter category). Drought and effects from roya in coffee were reported as the two factors requiring the greatest response. In Haiti, the overwhelming response to these two shocks/stressors was 'we did nothing.' It is unclear whether this reflects an underlying sense of defeat on the part of these farmers, or a calculated choice of where and how to invest effort and resources. In both Nicaragua and Honduras, the majority of respondents felt that their coping mechanisms had left them in a better position. Farmers in all countries mentioned that they are taking the hits and attempting to stay afloat, but are also considering the ways that they can adjust practices to get ahead. The climate stations and plan for an early alert system represent one example of a potential transformation in Nicaragua, through a belief that access to information and an effective communication network can and will inform and inspire behavior change.

9.3.2 *Coffee price/income instability*

Although the instability of coffee price was a perceived vulnerability across the board, the survey respondents were acutely aware that real change on this issue would have to happen at a systems level. The "C" market, where the commodity price of coffee is set was recognized as the seat of power, and while farmers mentioned responses such as trying to improve the yield and/or quality of their crop, and gaming the sale date – these were seen as marginally effective and all were absorptive strategies. When facing low prices other strategies included attempting to cut input costs, taking out loans and attempts at diversifying sources of household income. In Honduras (60%) and Haiti (36%) respondents said they felt they were seeing the same results regardless of their coping mechanism, which most often was working on incremental improvements in yield and quality. In Nicaragua, a slight majority (43%) felt their responses were leaving them better off, but nearly as many (40%) felt they were seeing essentially no change from their efforts. This likely reflects the deep sense of helplessness felt by most coffee producers on this issue. In other words, most farmers, with the exception of Nicaraguan cooperatives, are absorbing the prices that the market imposes on them.

Coffee farmers worldwide have tried to adapt to their lack of control in price by seeking alternative markets. Examples of these alternatives include certifications such as Fair Trade and organic, which have shown mixed results, and that tend to work best when farmers are organized in strong cooperatives (Méndez et al., 2010). Other, more advantageous alternative market opportunities, which could approach a transformative category, include direct trade and profit sharing options. However, gains have been limited in terms of the number of farmers that a relatively small group of progressive roasters can support. For these options to approach transformation, they would have to go beyond better pricing and address the inequities of the coffee value chain, where northern actors perceive around 45% of the value and coffee farmers about 5%. In this context, markets that are more direct and can offer higher prices, as well as diverse support to cooperatives (i.e., capacity building for quality, management, etc.), have the highest potential (Borrella et al., 2015). In addition, it is worth mentioning farmer-led initiatives, such as the Small Producer Label/Symbol (www.spp.coop), which is an experiment seeking, among other objectives, to ensure farmer demands on international labeling. The impact of low prices is especially problematic for farmworkers, since they are considered an 'input' and when costs are being cut, their (already low) daily wages are at risk.

9.3.3 *Food Security*

With the exception of producers in Nicaragua, who are diversifying into new crops such as turmeric, ginger and passion fruit (an adaptive response), all of the strategies shared by respondents fell into the absorptive category. These included seeking credit/taking out loans, off-farm labor and rationing food. Of the strategies mentioned, the perception was that these generally resulted in positive/neutral effects in Honduras (reported response for each was 48%), nearly equal for Nicaragua (45/43%), and either neutral or negative for Haiti (36%/39%). Although we were not able to go deeper in terms of why similar responses produce different results, recent work by Donovan and Poole (2014) suggests that households that have

historically accumulated more livelihood assets are in a better position to utilize new or additional resources or opportunities. In addition, we have to be aware that the challenging situation of most of these farmers prevents them from accurately 'taking stock' of how specific interventions affect their livelihood outcomes. This type of reflection is an area ripe for collaboration among farmers, development organizations and researchers, which unfortunately does not happen frequently as part of project cycles. Diversification was recognized as an important option for improving food security status, but respondents mentioned that it requires investments of time, resources, and willingness to learn. These are requisites for success and reflect an ongoing problem connected to lack of sufficient training and support for new endeavors.

9.4 PROJECT COMPONENTS AND CATEGORIZATION OF INTERVENTIONS

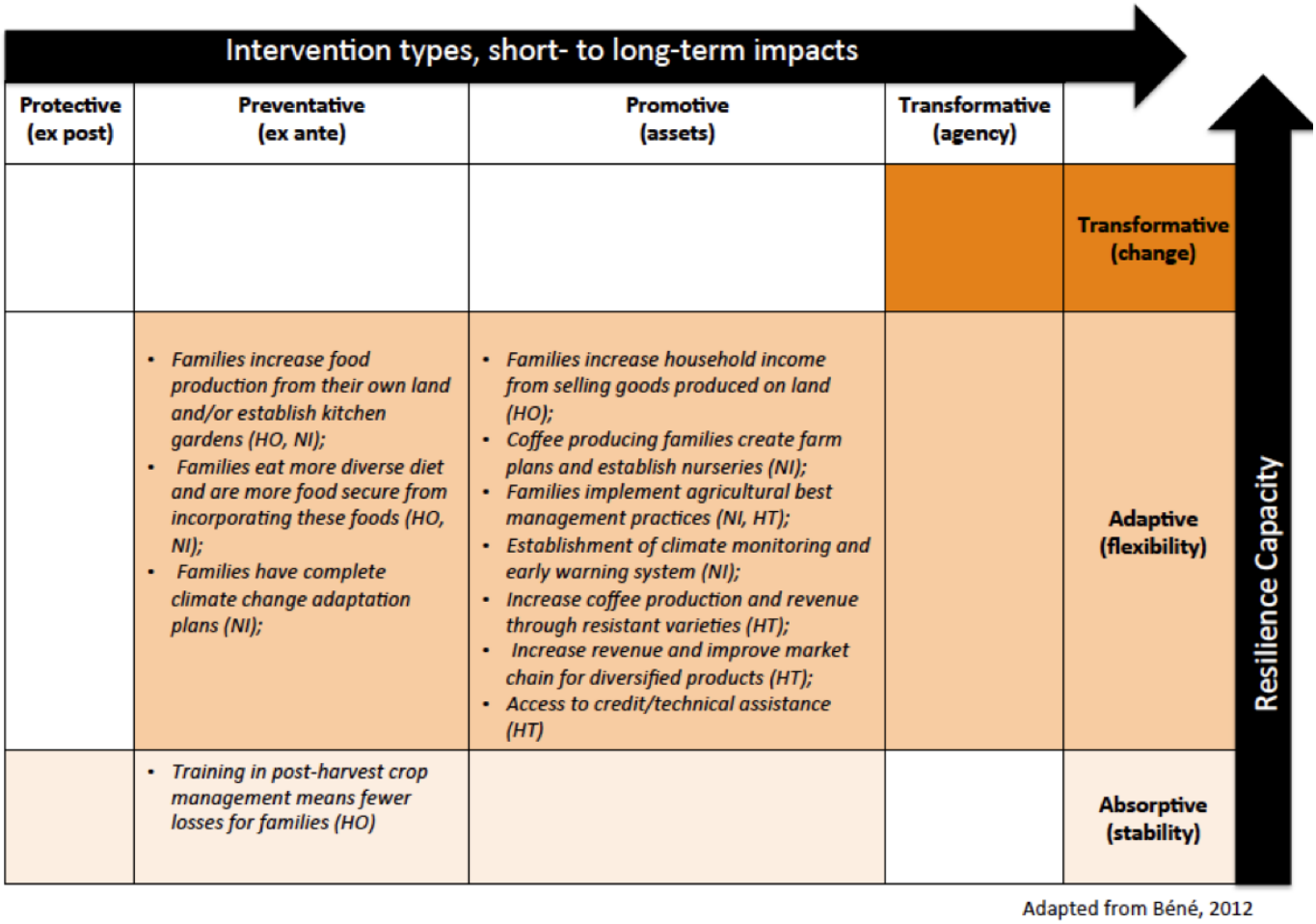
In each of the case study sites LWR has targeted its interventions specifically focusing on the interaction of these producers and their dependence on coffee. This means taking on shocks and stresses that are both idiosyncratic (affecting one household) and covariate (community/region-wide) – e.g., both strengthening households' capacity to deal with a crop failure on their farm and responding to low prices for coffee and high prices for basic grains that affect the entire region. One approach for assessing project efforts to increase resilience in coffee dependent communities is to categorize the interventions along a continuum and then use the recent vulnerability assessments and resilience typologies to identify programmatic gaps and opportunities (see Table 16). For this we followed Béné's model which categorizes project components in terms of their contribution to resilience, as follows: 1) Protective (ex-post), provide relief from deprivation; 2) Preventative (ex-ante), avert deprivation and deal directly with poverty alleviation; 3) Promotive (assets), aim to enhance real incomes and capabilities; and 4) Transformative (agency), address concerns of social equity and exclusion (Béné et al, 2012). See Figure 5 for a visual of this relationship.

Since the projects described in the case studies are not disaster relief, nor are they ongoing safety nets (food provision, etc.), none of the activities fall under the protective category; so we have chosen to omit it for this discussion. None of the projects are explicitly focused on challenging power structures or systemic changes, so we have also omitted the column for categorizing these interventions as transformative. However, the use of a cellular information exchange network in Nicaragua has the potential to support larger processes of co-learning in the future, which could strengthen the agency of producers and cooperatives. This could evolve into an intervention that can be categorized as transformative. To date the project foci and activities are largely preventative and promotive as shown in Figure 19.

Many resilience frameworks require significant investment, time and effort in training, outreach, analysis and technology. At its best, resilience work is long term and ideally has a component that engages with change at the structural systems level. But an important question in

assessing current resilience work, and making recommendations for how to move forward, is considering how these ideals interact with organizational realities. As is evidenced by the case studies, the target population of coffee dependent communities in Latin America and the Caribbean represent a great breadth of strengths and a daunting diversity of challenges. The current resilience projects are, as shown above, middle of the road – with activities that are neither basic aid nor transformative. Knowing that, and espousing the goals of building resilience capacity in coffee-dependent communities, surfaces some important questions, as

Figure 19. Categorization of LWR interventions, by country.



Adapted from Béné, 2012

9.5 PROGRAMMATIC GAPS AND OPPORTUNITIES

Many recommendations for climate change adaptation in agriculture in general, are 'in-line' with the sustainable development goals of the specialty coffee industry. As mentioned in the 2014 Coffee Barometer, these include access and support for better agricultural management practices, access to markets, financing, insurance, information (e.g., more current and accurate information about climate and coffee-price predictions), and improved use of technology. A recent USAID report on the relationships between market systems and resilience includes four determinants of market system resilience – (Irwin and Campbell, 2015, p. 12). We outline them below with examples from each of the case studies to show how the target communities are engaging with these concepts and offer suggestions for expanded support/guidance/intervention in these areas.

1. Diversity of related products and diverse market channels (preferably with different risk profiles)

– Nearly all of the farmers we spoke with (including the farmworkers in Nicaragua, as they are subsistence farmers, in addition to their roles in the coffee supply chain) have some diversity of products that they are managing, including coffee, maize, beans, cacao, plantains, bananas, passion fruit, ginger, turmeric, honey, manioc, sweet potatoes, and taro among others. However, strength of market is an area of vulnerability across the board. The coffee farmers are all price takers, and threats from climate change are creating concerns about the continued feasibility of coffee cultivation for some. Although crop diversification is a popular strategy, there are currently no strong markets for most secondary cash crops. Providing support for diversification strategies, including diversifying among varietals for established crops and leveraging social networks to connect producers with more reliable and/or lucrative markets is an area of opportunity for international development organizations.

2. Redundancy of multiple buyers, sellers and service providers

– Within the specialty coffee industry there are currently multiple potential buyers, especially when the coffee is eligible for certifications, and with growing potential for both direct trade and domestic markets. That said, the role of cooperatives and support organizations, such as Cafenica and IHCAFE are invaluable to producers as alternatives to participating in local markets are dominated by intermediaries. Producer organizations fill a niche for both connecting to market and technical assistance. Both Honduras and Haiti, especially, would benefit from connections to additional markets, and each of the sites is struggling with the ongoing problem of insufficient technical assistance/technical service providers. Cell phone networks and other uses of technology offer options for addressing this through new means for collecting and disseminating information to isolated rural populations. While NGOs and industry members could play a lead role in responding to either or both of these identified gaps, international development organizations are likely better positioned to provide bridging roles related to identifying local technical assistance resources and reaching out to key players to assist with expanding access to markets within the specialty coffee industry.

3. Trusting relationships that allow cooperation, communication, learning and innovation –

While the specialty coffee industry prides itself on embodying these qualities, producers are still struggling. The question then, is how can these values be further developed/adopted so that producer well-being and success is as important as profit reported to shareholders? As alluded to by Mark Lundy of CIAT during a presentation on resilience to the Specialty Coffee Association of America (Lundy, 2016), the industry will be stronger and more resilient when all parties along the supply chain truly acknowledge and value their co-dependence. Encouraging each player along the supply chain to specialize in their area (production, export, roasting, etc.), while genuinely acting on values of mutual benefit will allow each party to remain in their wheelhouse, while also strengthening the voice and improving the livelihoods of the producers and farmworker. This, in turn, will contribute to a more resilient supply chain overall. In any supply chain where there is competition among actors, achieving trust and full cooperation is a challenge. For example, direct trade relations might pre-suppose that farmers will maintain a certain exclusivity with a particular buyer, which may not be ideal for the growers. Being able to negotiate these obstacles to achieve the highest level of benefit for all, represents one of the greatest challenges within a value chain seeking higher sustainability.

4. Market governance and policy environment characterized by transparency, equity and consistency

– Similar to above, the specialty coffee industry has taken great steps to improve transparency and traceability through certifications and other industry standards. However, there are still issues such as farm labor and the role of women within the industry that reveal severe limitations to achieving improved equity across the coffee value chain. This also includes issues of how much value producers in the South obtain, compared to buyers and roaster in the North. International development partners with a social mission are in a strategic position to further strengthen an equity agenda within the specialty coffee industry. The long-term experience and knowledge of coffee communities held by many industry NGO partners is of great relevance for informing decisions related to coffee supply chain outreach and support to smallholder growers and cooperatives. The challenge is to find the right venues to communicate this information effectively to the key industry players.

10. LESSONS LEARNED

Several important lessons emerged from the literature review and fieldwork associated with this study, which is synthesized in the following paragraphs.

10.1 THE CRITICAL ROLE OF THE CONCEPTUALIZATION OF RESILIENCE AND THEORY OF CHANGE FOR INTERVENTION APPROACHES

One of the common framing questions in resilience work is 'resilience for whom, to what?' Since despite best efforts and intentions, resilience activities can benefit some at the cost of others, it is also important to consider the question of 'resilience in whose interest?'. In the projects that are the focus of this study, LWR has designed interventions to directly benefit coffee farmers and farmworkers in their target communities. 'Connecting the dots' and approaching change in a holistic manner, are characteristics of resilience interventions. But just how important is it for producers themselves to engage with the concept of resilience? Our conclusion is that the greatest utility from engaging producers in conversations about 'resilience' comes from the framing it provides for considering tradeoffs among livelihood assets, and thinking about both short- and longer-range time horizons. "Resilience, like vulnerability, is socially constructed, endogenous to individual and groups (households, communities), and...contingent on knowledge, attitudes to risk, culture and subjectivity" (Béné, 2016 p. 166). Ensuring that there is a clear and agreed upon understanding of the path toward and actions required for resilience is especially crucial as many of these communities are facing climate predictions that question whether they will be able to continue as 'coffee dependent.'

From the industry side, we can start by asking what players within the industry are using a resilience approach...and, in whose interest? In this sector, the interests are likely more directly tied to profits and business viability. While there may be benevolent intent and genuine desire to 'help' smallholder coffee farmers, at the end of the day industry members will prioritize investments that strengthen their supply chain. Sustainability has been an industry buzzword that seems to help actors along the supply chain to consider producer well-being as critical to their business health. However, as mentioned above, in the name of resilience there is a need to reconceive of the traditional relationship of production by farmers and project support from supply chain partners to a more accurate manifestation of the mutual reliance among these parties. Existing relationships need to move past the idea of projects and programs to reflect the interdependence of coffee producers, farmworkers and other supply chain participants. Ideally, that change in conceptualization would result in additional investments in those communities for the long term, or restructuring of allocation of profits along the chain so that producers and other actors 'at origin' can make the needed investments to ensure a long-term supply that approaches resilience.

10.2 THE FARM AND LANDSCAPE AS INTERRELATED SYSTEMS.

Agroecosystems are complex, dynamic and diverse, so they lend themselves to holistic resilience approaches, but integrated frameworks are also messy and hard to measure. The "interdependence of market systems and ecosystems is particularly clear in areas where livelihoods are reliant on agriculture, which in turn depends on natural resources and is sensitive to climate change" (Irwin, 2015, p. 5). What this means for resilience work in coffee dependent communities is that it needs to concurrently engage with both households and at a higher systems level, which could translate into engaging cooperatives, governments, industry associations, academic institutions or some combination of all of these players.

Coffee is not only an international priority because of its contribution to the GDP of the countries where it is grown. It also plays a critical role in maintaining some of the most biodiverse agroecosystems in the world. Therefore, increasing resilience in these communities is critical to the national economy, broader regional and national environmental conservation, as well as strengthening the livelihoods of smallholder producers. An agroecological approach reinforces the importance of both the human and ecological aspects of building resilience through many of its principles (see Scarborough et al., 2014). The most relevant ones to resilience in this context are presented below:

- Conserve and increase agroecosystem diversity at multiple scales
- Conserve and increase soil health and nutrient cycling
- Conserve and increase the ecological mechanisms for regulating pests and diseases
- Minimize dependence on external, synthetic inputs
- Increase the production of agroecosystems without compromising the natural resource base
- Diversify livelihoods to mitigate risk
- Prioritize and improve local food production to pursue food security and sovereignty
- Strengthen local organizations and farmer associations
- Respect local expertise and integrate local agricultural and ecological knowledge
- Maximize the use of renewable energy
- Conserve water and optimize its use

These agroecological principles provide direction towards key foci for building agroecosystem resilience, and as guides to where it is important to engage with other players to maximize positive impact as mentioned above.

10.3 THE IMPORTANCE OF CONTEXT AND RELATIONSHIPS FOR SYSTEMS-LEVEL RESILIENCE

Resilience requires that systemic (and structural) issues be addressed even as individuals are wrestling with their own resilience capacities. This question of interactions between a whole and its parts is relevant to the future the coffee industry is facing. Predictions for the zones that will remain suitable for the production of Arabica coffee, point at the changes in the future capacity to grow it in certain regions. According to these scenarios, some of the coffee-dependent communities that were the focus of this study will either need to leave coffee cultivation altogether or significantly alter their production practices. These assertions sound grave, and especially so to farmers who have cultivated coffee for generations with both land and identity both tied up in its production. That said, resilience theory discusses the idea of path dependency and past being the best predictors of future. With intentional planning, this means "...actors in the system and, by extension, the system itself, (can) anticipate the future based on experience rather than simply react(ing) to present conditions" (Cabell and Oelofse, 2012). Climate models and monitoring activities represent one example of this – where with intentional planning and data that is regional instead of limited to a single plot, coffee farmers can adjust their practices and/or make informed decisions about the future suitability of their land for particular crops/varieties. This improved ability to act based on lessons learned speaks to the value of investment in skill building and knowledge sharing that LWR and other organizations are already pursuing. Being able to draw out community knowledge around context and connect that to other knowledge and resources that are potentially not available within the local context will help to develop long-range plans that include contingencies, while also building both personal capacity and supportive networks so that the plans are actually realized.

In contrast to direct supply chain partnerships within the coffee industry, international development partners may have a unique role, since they can be committed to individuals and communities independent of whether the farmers continue in coffee or switch to another crop. Taking action can be seen through three main steps, as follows: 1) focusing, first, on helping households to stabilize and make plans for a viable future; 2) investing in people and communities so that their own improved resilience capacity allows them to fare better in the face of shocks and stresses; and 3) leveraging the stability generated through a higher resilience capacity to support further development (Irwin and Campbell, 2015). A suggested pathway for best accomplishing these steps includes combining multiple interventions, capitalizing on existing structures, ensuring women's empowerment (Irwin, 2015), incorporating both human learning and empowerment, and further strengthening and developing social capital (organizational affiliations and networks). This course of action requires acknowledgement of the present situation, with an orientation toward the future and careful analysis of choices and tradeoffs, where "...aspirations (are) directly linked to resilience, such that those who are willing to make investments that enhance well-being may durably and autonomously stay out of poverty" (Frankenberger, et al, 2013, p. 17).

11. RECOMMENDATIONS FOR FUTURE RESILIENCE WORK IN COFFEE COMMUNITIES

11.1 RESILIENCE IS A PROCESS THAT REQUIRES LONG-TERM INVESTMENT

"A key theme that cuts across all definitions of resilience is that it shifts the focus of preparing for and responding to shocks, from addressing immediate needs, to enhancing capacities to meet longer-term development objectives in the face of shocks and stresses" (Irwin, 2015, p. 7). Resilience interventions require longer-term visions that seek to tackle issues at multiple levels, from multiple angles and at multiple time scales. This means that interventions either need to involve a series of short term investments that build upon each other – potentially addressing some low(er) hanging fruit – while there are also concurrent activities engaging at other levels that will lead to transformational and lasting change. The caveat to this is that longer-term investments should also include vigilance toward identifying emergent properties and a constant openness to adapting and adjusting course as conditions change. For example, the FSM project in Honduras was not originally conceived as a resilience intervention. In moving forward with a resilience focus, based on the findings of this study, project activities might include technical assistance for improved production practices, establishing a producer organization to improve market access, a concerted effort to find direct trade/solidarity buyers and partnering with a financing organization to provide low-interest loans and training on financial literacy.

11.2 FLESH OUT CRITICAL QUESTIONS AROUND DIVERSIFICATION STRATEGIES

Despite warnings that "..livelihood strategies shouldn't be dependent on at-risk resources or institutional arrangements" (Schipper, 2015, p.14), smallholder coffee producers are vulnerable on both counts. That said, and as mentioned above, interests from both the specialty coffee industry and broader environmental conservation serve as incentives for ensuring that the agroforestry polyculture systems maintained by these smallholder farmers are sustained. Diversification strategies (both for income and biodiversity) have been frequent recommendations for bolstering both ecological and human well-being in these communities. However, there has not been a systematic assessment of what diversification strategies have proven most successful, in what contexts and in what combinations. To advance the conversation around diversification strategies, and ensure that they are sound, based on reality and supported through to success, we offer three recommendations:

1. Instead of focusing on diversifying activities, focus on diversifying risk

When all livelihood activities are susceptible to the same shock (e.g., drought), households are not significantly diversifying risk, and therefore are not making maximum progress toward increasing resilience. Instead, diversification for household resilience often requires off-farm/non-agricultural labor to be included in the mix (payment for ecosystem services, agritourism, value-added products, etc.; Mercy TANGO, 2013). Providing a menu of options and/or start-up funds for individual initiatives was the preferred mode of support mentioned by study respondents – there was articulated resistance to 'pre-cooked' projects that come and go on someone else's timeline and criteria.

2. Involve households in assessing benefits/burdens (tradeoffs) of diversification strategies

Remembering that diversification strategies ask households to acquire new knowledge, new skills and assume new risk, and given that diversification strategies devolve almost all of the responsibility for positive change to the household, it is critical that building decision-making skills are component parts of diversification options. One tool for this is the 'Gendered Sustainable Livelihoods Approach', which is based on the classic asset analysis of the sustainable livelihoods framework combined with a gendered analysis framework developed by Feldstein and Poats (1989), and which applies three basic questions: "1) with regard to labor; *who does what?*, 2) incentives and benefits; *who benefits?*, and 3) governing arrangements; "*who has access to and control over resources*?" (*Hoeve*, 2005, p. 3). We propose asking two more questions, which are: who will provide the necessary technical support (ongoing, not just initial training); and what are the contingency plans if/when problems occur? As gender equity and women's empowerment are foundational to building resilience, considering who will bear the responsibility for and reap the benefits from each possible strategy is critical to ensure that additional work is not assigned to members who are already overburdened or assigned to those who will benefit least from them. This exercise is also useful in helping households to consider the timeframe for new strategies (and whether benefits will be delayed, but worth it) and consider tradeoffs of risks and rewards.

3. Support people, not just projects

Many of the people living in coffee-dependent communities are subjected to shocks and stresses with such frequency that they are living and functioning in a "…constant state of incomplete recovery," (Bene, 2016 p.165) Considering the psychological toll of this (stress, depression, etc.) and the impact this has on people's ability to function effectively is important. This means meeting people where they are and encouraging/enabling positive change. Reestablishing healthy soil takes time, patience and continued inputs – so too with reestablishing healthy attitudes and positive outlooks. Given continued attention, both can contribute to improved resilience in coffee dependent communities.

The Nicaragua case offers an opportunity for integrating these diversification recommendations. While the existing project includes several diversification strategies (in terms of new coffee varietals, alternative food/cash crops, and seed banks and home gardens for food security), project participants and partners both expressed a gap in terms of helping individuals and households to feel competent and capable in the face of seemingly insurmountable challenges. This relates to several themes, including self-confidence, agency, choice and decision-making skills, and is impacted by environmental factors as well. Specifically, one key actor mentioned that she believes many smallholder farmers in Nicaragua are essentially functioning with post-traumatic stress disorders (PTSD), as a result of living through years of armed conflict. This is not unique to Nicaragua, as drug/gang violence, armed conflicts and continued political unrest have a historical and continued presence across the region. The implication of this for development interventions focused on resilience, is that diversification activities must be tailored to the specific context, and be accompanied by work at the individual and household level around building human assets. In order to address these issues, specific project activities should address the strengthening of agency, decision-making skills, gender equity and developing/strengthening social support networks. These complex themes are also areas that would benefit from research that better elucidates the key issues (i.e. is it PTSD or current violence), on the one hand, and also collaboration with organizations or projects that specialize in providing support of a social-psychological nature. Opening these conversations with project partners and participants would be a good step toward integrating these topics in future project design and interventions.

11.3 A RESILIENCE APPROACH TO MONITORING AND EVALUATION (M&E)

Resilience is a concept with many interpretations and even more recommendations for how it should be measured. This comes as no surprise for something that is complex, dynamic and, in some ways, subjective. Unfortunately, the response to this morass can lead to falling into the trap of trying to adjust existing measures by just calling them 'resilience indicators', instead of embracing the complexity of what it really takes to assess resilience capacity and trajectory (Frankenberger et al, 2014). Instead of solely focusing on outcome indicators, resilience projects need to also include process and behavior-based indicators, the presence of which "...identifies resilience in the system; their absence or disappearance suggests vulnerability and movement away from a state of resilience" (Cabell, 2012, p. 2). Resilience work, as a function of its focus on holistic responses, also challenges the more traditional 'project' model that expects quick and demonstrable returns. This is due in part to how success is defined, since "...the ultimate impact of a resilience intervention should not be measured in terms of the speed at which people or households get back to their original level of income/assets...but rather by the types of adequate responses put in place by the households in the face of adverse events" (Bene, 2016, p. 166). This reinforces the need for resilience M&E to be willing and able to account for emerging properties and detect appropriate causal relationships. Both developmental and principles-based evaluation (Patton, 2010) offer options for this that could potentially complement more traditional M&E frameworks.

This idea of considering and measuring 'adequate responses' is especially salient to the case of Haiti, where the highest rates of erosive coping strategies were observed. Defining appropriate project goals is as germane to resilience initiatives as any other development work. However, given the holistic nature of resilience as a concept – it leaves open the opportunity for recognizing influential factors mid-course and adjusting project interventions to respond accordingly. For example – in Haiti, the lack of access to financing is detrimental to household resilience; preventing the purchase of agricultural inputs, meaning keeping children out of school,, and thwarting traditional coping strategies like 'ti komes.' However, this study revealed abundant social capital, which could potentially be harnessed in response to the lack of financial capital – for example, leveraging the communal spirit to create a pooled risk credit model. This kind of nimbleness and responsiveness within project design will only be functional with a clearly articulated project goal and theory of change that are used as guiding forces, and careful monitoring and evaluation tools that allow for the identification of emerging trends and provide early and accurate signals about project effectiveness.

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13. APPENDIX 1. INDICATORS OF RESILIENCE, AGROECOLOGICAL PRINCIPLES, BASED ON THE SCIENTIFIC LITERATURE AND REFERENCES TO STUDIES

Table 17. Indicators of resilience, agroecological principles, based on the scientific literature and references to studies (adapted from (Morris et al., in preparation).

Indicator of resilience	Agroecological Practice	Research findings
Microclimate control	Incorporation of shade	Shade trees decrease air temperature fluctuations, humidity and solar heat (Camargo, 2010, Siles et al., 2010, Lin, 2007)
Soil moisture retention and water infiltration	Incorporation of shade and leaf litter	Coffee agroforestry had higher soil bulk density, soil organic Carbon and water infiltration, better root distribution, and reduced soil temperature, and water runoff than coffee monocultures (Tumwebaze et al., 2016, Cannavo et al., 2011, Camargo, 2010)
Minimization of erosion and landslide damage	Shade trees, vegetative complexity, and leaf litter	Coffee agroforests with higher vegetative complexity and more ground covered by leaf litter had less erosion and landslides. (Blanco-Sepulveda 2015, Philpott et al., 2008)
Nutrient & Nitrogen (N) use efficiency	Incorporation of shade	N losses in coffee monoculture are higher than in coffee agroforests where litter and pruned branches contribute to N stores. (Tully et al 2012, Avelino et al., 2011)
Maximization of coffee yields	Shade management	Shade cover between 30-45% had a positive effect on coffee yields. (Soto-Pinto et al., 2000)
Pest and disease control	Agroecosystem complexity and shade; Coffee breeding for disease resistance; Biological controls	■ Leaf litter prevents spread of soil diseases. ■ Shade attracts birds, which can contribute to insect pest control, while harboring beneficial insects (Avelino et al., 2011, Jaramillo et al., 2011) ■ Hibrido de Timor (HDT), Caturras and Catuai varieties are resistant to most coffee rust races. (Silva et al., 2006)
Income stability/security	Crop insurance & diversification; Cooperatives & other support networks; Certified & high markets	■ Farmer vulnerability reduced through crop and income diversification; access to insurance/financing; and irrigation infrastructure (Rahn et al., 2012) ■ Long-term support of an NGO and a highly motivated local population were essential in allowing for building adaptation (Ruiz Meza, 2014)

Indicator of resilience	Agroecological Practice	Research findings
Food security	Crop diversification; Food production; Livelihood and income diversification	■ On-farm biodiversity supports economic and social resilience through food crops, medicinal plants, income, cookstove fuel source, and timber (Mendez et al., 2010) ■ Higher crop diversity provides ecosystem services and supports more consistent yields from year to year. (Chappell and LaValle, 2011)
Empowerment/ strengthening of social capital	Participation in cooperatives, networks, and higher value markets; Participation in farmer field schools	Community resilience increases with expanding networks of support and spaces of engagement. (Tompkins and Adger 2004)

14. APPENDIX 2. DETAILED STATISTICAL PROCEDURES AND ANALYSES

To analyze the information collected we undertook a diversity of statistical procedures. These included statistics to describe the data and to explore trends (means, frequencies, etc.). To test differences in means and frequencies we used non-parametric statistics, given the non-normal distribution of the data. These included Mann Whitney U test for differentiating between two means and Chi squares to test significance among frequencies of different variables. Pearson or Spearman rank correlation analyses were used to determine the strength of association between continuous variables.

The clustering procedure we used to classify farmers into different types was a two-step cluster analyses. We determined cluster membership and the optimal number of clusters using Schwarz's Bayesian information criterion. For each cluster analysis we selected four variables (extracted from surveys) identified to be important indicators and/or correlates of resilience. We compared the means of each variable using the non-parametric Mann Whitney U test, given that the data was not normally distributed. To better assess the characteristics of each typology we also explored the distribution of other potentially explanatory variables within each cluster. These variables included the number of subsistence crops and the highest level of education within a household. For the Honduran data set we added a third variable, indigenous heritage, to the secondary evaluation procedure.

15. APPENDIX 3: LIVELIHOOD ASSET AND INDICATORS USED IN SPIDER GRAPHS

Table 18. Livelihood indicators and how they were calculated.

Asset category	Indicator	How it was calculated
Natural	Good soil	Refers to a positive response in terms of soil quality for coffee plots, from a range of good=1, medium=0 and bad=0. Although leaving out the medium category in the analyses underrepresents this answer, to ease comparison we decided to keep it as a binary figure.
Natural	Diversified shade	Refers to positive response regarding managing natural/rustic, mixed or reforested shade in their coffee plantation.
Physical	Irrigation	Refers to positive response to having irrigation equipment/access, excluding hand watering cans.
Physical	Food storage	Refers to what we categorized as efficient methods of food storage against pests and the elements, including a metal silo, hermetic plastic bags, barrels or plastic bottles. While other forms of food storage were mentioned (sacks, open containers, etc.), because of the accompanying food loss associated with these options, they were not counted.
Financial	Credit access	Refers to the average positive response to access to credit from formal institutions, including cooperatives, micro-credit institutions or projects, and other farmer organizations. It does not include informal credit from family members or individual lenders.
Financial	Profit	Refers to the average positive response when asked whether they had earned a profit (1), in general terms, from their past year's agricultural activities. All other answers were considered a negative response (0).
Financial	Access to markets	This was a direct yes/no question asking interviewees if they had access to markets. These results are heavily skewed to refer to the producer's primary cash crop (coffee).
Social	Number of support organizations	Respondents were asked what organizations they were involved with, type of support and their role, and satisfaction with the affiliation. Given the diversity of organizational types mentioned (NGOs, cooperatives, churches, schools, etc.) there was a wide range in reported types of support. Some respondents reported a range of different organizations, each providing specialized support, while other organizations provided multiple and different types of support.
Social	Mean network quality	Refers to the average positive responses of the quality of relationships with the organizations that were reported as providing support. We counted those where the relationship was perceived as strong, from a range of good=1, medium=0 and bad=0.

Table 18 continued. Livelihood indicators and how they were calculated.

Asset category	Indicator	How it was calculated
Human	MAHFP	Months of Adequate Household Food Provisioning (MAHFP) is a recognized standard for determining food security. It represents the number of months per year when respondents perceived they had access to an adequate food supply for their household.
Human	Average education	Average education per member, per household was calculated by assuming a minimum number of years per educational category (primary=1, secondary=6, high school=9, university=13) and then multiplying it by the number of people per household with that level of education. Total figures for each educational category were then summed and divided by the number of people in the household to calculate the average number of years of education per person per household. This represents a conservative estimate, as it is likely some of the family members may have studied for more years than the minimum for each category. Although an underestimation, this figure still differentiates those households with more members going to higher levels of education, even if representation of the number of years may be on the low side.

16. APPENDIX 4. CALCULATION OF CLUSTER GROUP (FARMER TYPES) POSITIONS IN RISK/OPPORTUNITY MATRICES.

Process for determining placement of bubbles within risk/opportunity matricies–

Scaled each square into four equal sections along both x- and y-axes (resulting in 16 subsections for each matrix). Values were then estimated based on a combination of numerical scores from the survey data and weights that were assigned to qualitative data obtained through open-ended survey questions, conversations with key actors and focus groups.

Agroecosystem risk/opportunity matrix–

Factors that contribute to improved resilience opportunities include number of agroecological practices, % of survey population reporting good soil, and number of diverse plant species mentioned in the survey. Positioning toward the top of the matrix represents a more advantageous relative position. The ranking from low to high for the various cohorts was Honduras Type 1, Nicaragua Type 2, Nicaragua Type 1, Honduras Type 2, Haiti Type 1, and finally Haiti Type 2. The total for Haiti Type 2 was approximately double that for Honduras Type 1. The bubbles were then positioned within the four vertical boxes in estimated relative position.

The limit/constraint score is a standardized land-holding score. More land holding indicates a position of relative advantage/less vulnerability, or toward the left-hand side of the matrix. The ranking from low to high for the various cohorts was Haiti Type 1, Nicaragua Type 1, Honduras Type 1, Haiti Type 1, and essentially equal values for the Type 2 groups from all three countries. The bubbles were then positioned, maintaining their vertical position related to resilience factors along the four horizontal boxes, representing an estimation of relative position.

Coffee production risk/opportunity matrix–

Resilience factors include weighted values for the reputation of coffee quality from the region (for countries as a whole – not subdivided by Types), and yield calculations from survey responses. The ranking from low to high for the various cohorts were Haiti Type 1 and 2, Honduras Type 2, Honduras Type 1 and Nicaragua Types 1 and 2. The bubbles were then positioned within the four vertical boxes in estimated relative position.

The limit/constraint score includes access to markets (includes percentage reporting good access to markets (by Type), and a weighted value including for sales to coyote v. cooperative and stable v. unstable buyer relationships (last two categories are for countries as a whole – not subdivided by Types)), conventional versus organic production (for countries as a whole – not subdivided by Types), and whether the average elevations will be within the range for specialty coffee (800-1400masl) if climate prediction models hold (for countries as a whole – not subdivided by Types). The rankings from low to high for the various cohorts were Haiti Type 1, Honduras Type 1, Haiti Type 2, Honduras Type 2, Nicaragua Type 1 and Nicaragua Type 2. The bubbles were then positioned, maintaining their vertical position related to the resilience factors along the four horizontal boxes, representing an estimation of relative position.

Information and support risk/opportunity matrix–

Resilience factors include number of organizational affiliations, perception of network quality (from survey responses) and informal social networks (from key actor interviews and focus groups). Haiti scored highest in informal social networks but lowest in the other two categories, Honduras had the highest number of affiliations and Nicaragua had the highest scores for mean network quality. The bubbles were then positioned, maintaining their vertical position related to the resilience factors along the four horizontal boxes, representing an estimation of relative position.

The limit/constraint factors include perceptions of gender dynamics and political agency (extracted from key actor interviews and focus groups), and then the percentage of reported use of positive coping mechanisms in response to climate change, coffee price fluctuations and food insecurity (taken from survey data). The rankings from low to high for the various cohorts were Haiti Type 1, Honduras Type 2, Haiti Type 2, Honduras Type 1, Nicaragua Type 1 and Nicaragua Type 2. The bubbles were then positioned, maintaining their vertical position related to the resilience factors along the four horizontal boxes, representing an estimation of relative position.


PARCELA
DEMOSTRATIVA
VARIEDADES
DE CAFE